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People and the Sound

MINERAL RESOURCES AND MINING

A Planning Report prepared for the New England River Basins Commission by the U.S. Department of the Interior, Bureau of Mines

New England River Basins Commission

The Long Island Sound Regional Study is a "level B water and related land resources study." It was conducted under provisions of the federal Water Resources Planning Act of 1965. The Plan which has been developed was prepared by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of its region, which includes New England and the New York portions of Long Island Sound.

The plan for Long Island Sound recommends a program for action by federal, state, and local governments; it does not bind them to undertake specific recommended actions. To assist in the evaluation and implementation process, the following reports have been prepared:

A PLAN FOR LONG ISLAND SOUND: A SUMMARY. Highlights of the plan and a brief discussion of the rationale leading to recommendations.

A PLAN FOR LONG ISLAND SOUND: SUPPLEMENT. A more comprehensive planning document which enumerates the major alternatives considered in formulating the recommendations, together with an explanation of how the plan was prepared, who did the work, and background information organized both by subject matter and by geographical sub-regions of the Study Area.

PLANNING REPORTS. Each planning report was developed by a "Work Group," chaired by a federal agency, with the active participation of state and local agencies, other federal agencies and citizen and scientific advisors. These reports incorporate data (originally published in a series of Interim Reports) which estimate people's demands for the resources of the Sound region, the requirements needed to meet those demands, the existing capacity of the region to meet the requirements, and any deficiencies noted.

The second half of each planning report develops solutions by stating objectives in terms of satisfying defined needs, suggesting alternative ways to achieve the objective, evaluating each alternative in terms of environmental, economic, and social criteria, developing economic, environmental, and composite plans, and finally making recommendations.

The following Planning Reports were prepared:

Water Management by the U. S. Environmental Protection Agency, and the States of New York and Connecticut.

Land Use by Ralph M. Field and Associates for the U. S. Department of Housing and Urban Development.

Outdoor Recreation by the U. S. Department of the Interior, Bureau of Outdoor Recreation.

Fish and Wildlife by the U. S. Department of the Interior, Fish and Wildlife Service; and the U. S. Department of Commerce, National Marine Fisheries Service.

Shoreline Appearance and Design by the U. S. Department of the Interior, National Park Service and Roy Mann and Associates.

Marine Transportation by the U. S. Department of the Army, Corps of Engineers.

Power and the Environment by Federal Power Commission staff.

Mineral Resources and Mining by the U. S. Department of the Interior, Bureau of Mines.

Flood Damage Reduction by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.

Erosion and Sedimentation by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.

OTHER REPORTS published in conjunction with the Study are:

An Economic Perspective by the U. S. Department of Agriculture, Economic Research Service; and the U. S. Department of Commerce, Bureau of Economic Analysis. An examination of the economic and demographic trends in the region, with data for use as the basis of all projections made in the Study.

Shoreline Appearance and Design: A Planning Handbook by Roy Mann Associates, Inc., for the U. S. Department of the Interior, National Park Service. Recommended management procedures for protecting and enhancing the region's scenic resources.

Sources and Movement of Water by the U. S. Geological Survey, Water Resources Division; and the National Oceanic and Atmospheric Administration. A summary of the hydrology and climate of the region.

Soils by the U. S. Department of Agriculture, Soil Conservation Service. An inventory and analysis of soil composition in the region.

For a complete listing of reports published by or in conjunction with the Study, see Appendix A of the Supplement. Copies of these reports are available from:

New England River Basins Commission
55 Court Street
Boston, Mass. 02108

National Technical Information Service
Springfield, Va. 22151

MINERAL RESOURCES AND MINING
A Planning Report

Long Island Sound Regional Study
New England River Basins Commission
270 Orange Street
New Haven, Connecticut 06511

Prepared by the Eastern Field Operation Center,
U.S. Bureau of Mines
with contributions from the
U.S. Army Corps of Engineers

May 1975

FOREWORD

Long Island Sound is one of the Nation's unique and irreplaceable natural resources. An almost fully enclosed arm of the ocean, it has over 1,300 square miles of water surface and over 600 miles of coastline. Spreading eastward along both shores from the great metropolitan center which lies at the Sound's western end, a growing concentration of increasingly affluent people make ever greater demands on this urban sea. At the same time, there is a growing feeling that the conflicting demands are destroying the Sound, and that the problems must be resolved if the Sound is to be preserved.

The Long Island Sound Regional Study is a comprehensive planning effort by the Federal Government and New York and Connecticut, led by the New England River Basins Commission. Assisting the Commission are professionals from many disciplines representing the Federal, State, and regional agencies listed on the back cover, a Citizen Advisory Committee, and a Research/Planning Advisory Committee composed of members of the region's scientific community.

> THE GOAL OF THE STUDY IS TO PRODUCE A PLAN OF ACTION BY THE SPRING OF 1975 WHICH BALANCES THE NEEDS TO PROTECT, CONSERVE, AND WISELY DEVELOP THE SOUND AND ITS RELATED SHORELANDS AS A MAJOR ECONOMIC AND LIFE-ENRICHING RESOURCE FOR THE 12 MILLION PEOPLE WHO LIVE NEAR IT.

This planning report is one of a series. The first half of each report is problem oriented. It summarizes demands placed upon the Sound and adjacent lands, their capacity to supply these demands, and present or expected needs to be met, if it is determined that supply should meet demand. The last half of each report is solution oriented. It formulates tentative objectives and alternative measures for achieving the objectives. It evaluates the environmental, economic, and social implications of each measure and formulates alternative plans. One plan is tentatively recommended. The planning reports are printed and distributed before the final version of main report. Therefore, final recommendations are to be found only in the main report, scheduled for publication in the Spring of 1975. Planning reports in this series include:

Land Use	Recreation
Water Management	Fish and Wildlife
Shoreline Appearance & Design	Marine Transportation
Erosion and Sedimentation	Minerals
Flood Damage Reduction	Power and the Environment

SUMMARY

PURPOSE OF THIS REPORT. To assemble information on current and projected demand for and supply of mineral resources in the Long Island Sound (LIS) region with particular emphasis on sand, gravel, and stone, and to recommend a plan to meet future needs for these commodities.

HOW SIGNIFICANT ARE SAND, GRAVEL, AND STONE TO THE LIS PUBLIC?

They account for 3.5 percent of residential construction costs, 7.0 percent of commercial construction costs and 13.0 percent of highway construction costs --- no adequate substitutes are likely --- apparent consumption in 1970 was 9.0 million tons of sand and gravel and 4.3 million tons of stone --- projections of future annual demand differ --- Bureau of Mines projections: for sand and gravel, 16 million tons by 1990 and 20 million tons by 2020; for stone, 5.7 million tons by 1990 and 7.3 million tons by 2020.

WHAT REQUIREMENTS MUST BE MET TO SATISFY THE DEMAND?

The materials must be geologically available --- the extractive process must meet increasingly stringent socio-environmental standards --- sources must be located near the demand, or near transportation facilities.

WHAT IS THE CAPACITY OF THE REGION TO SATISFY THESE REQUIREMENTS?

Materials are geologically abundant in good quality on and off shore --- exceptions: no stone on Long Island, gravel in much shorter supply than sand everywhere.

Man-made limitations on availability of these natural deposits are severe --- natural deposits are becoming unavailable because of rapid rate of land development that preempts sites before they can be mined and restrictive controls that prohibit mining or make it uneconomical --- rehabilitation of abandoned sites is feasible --- environmental and enlightened economic goals should be compatible.

Production in 1970 in nine-county area was about 9.0 million tons of sand and gravel valued at $11.6 million and 4.3 million tons of stone valued at $8.7 million --- none came from marine sources.

Marine mining of sand and gravel in the Sound was significant in past --- is economically competitive now --- major limitations are legal and environmental uncertainty --- environmental problems can be minimized by avoiding silty bottoms.

Transportation is a major cost factor when demand centers deny themselves use of nearby sources --- trucks are used for short hauls, barge for long hauls, rail movement is minor --- sand, gravel, and stone constitute the second most significant commodity group (in tonnage and value) at LIS ports, ranking only behind petroleum products --- main flow is sand from Long Island to New York City and crushed stone from Hudson River and Connecticut to Long Island and New York City.

Cost. "In-bank" costs are rising rapidly, up 56-76 percent in Connecticut in 4 years, as available mineral commodities are being depleted --- production costs remain steady under advancing technology --- transportation costs rise as distances increase --- typical costs are $1.25 a ton, f.o.b. plant, doubling every 8 to 12 truck miles, or every 125 barge miles.

Future supply. Currently available reserves on Long Island will be depleted about 1985-90, sooner if preempted --- reserves in Connecticut could last many years at current consumption rates --- however, Connecticut reserves are being preempted rapidly by land use pressures --- also, the most readily available reserves are within New London County, far from the demand centers in Fairfield and New Haven Counties.

OBJECTIVE AND ALTERNATIVE MEASURES

Objective is to develop a plan to satisfy regional needs for mineral resources in environmentally, economically, and socially acceptable ways --- six alternative measures were considered --- sequential land use, mine the Sound, manufacture sand from stone, import from outside the region, modify construction specifications, and do not meet needs.

EVALUATION

The six alternatives were evaluated in terms of numerous environmental, economic, and social criteria. The environmental concepts recognized (1) the role mineral commodities play in maintaining the present environment, (2) that mining physically disturbs the environment, and (3) that properly controlled mining will have minimal effects on the environment. The economic concepts acknowledged (1) that mineral resources are finite, (2) that transportation costs are a major portion of the consumer's cost, and (3) that costs are distributed to all segments of society. The social concepts consider (1) that life, health, and safety are dependent on continuing supplies of mineral commodities, (2) that a time of crisis is approaching relative to needs for mineral resources, and (3) that numerous legal, political, and judicial difficulties will have to be solved.

ALTERNATIVE PLANS

Three plans were considered: one stressing environmental quality (EQ), a second, national economic development (NED), and a third, a combination of the two.

WORK GROUP RECOMMENDATION

Recommended was a composite plan stressing sequential land use with environmental safeguards, submarine mining, and some importation from outside the region.

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1.0 INTRODUCTION

The purpose of this planning report is to assemble information on current and projected demand for and supply of mineral resources in the Long Island Sound (LIS) region with particular emphasis on sand, gravel, and stone, and to recommend a plan to meet future needs for these commodities.

To accomplish its purpose, the first half of the report is problem oriented. The report --

- Examines the current and projected demand for the selected mineral commodities.
- Outlines major requirements that must be met in satisfying this demand.
- Describes current production and available resources.

The second half of the planning report is solution oriented. It --

- Formulates objectives.
- Identifies alternative measures for achieving the objectives.
- Evaluates the alternatives environmentally, economically, and socially.
- Formulates three alternative plans --- stressing environmental quality, national economic efficiency, and a composite of each.
- Recommends a plan and adjusts it to accommodate multi-purpose considerations and public input.

2.0 HOW SIGNIFICANT ARE SAND, GRAVEL, AND STONE TO THE PUBLIC?

2.1 Importance of sand and gravel

Sand and gravel are high-bulk materials of low unit value. They are in heavy demand in the construction industry. For example, the average value of sand and gravel in the United States in 1968, as a proportion of total construction costs, has been estimated at 3.5 percent for nonfarm residential construction, at 7.0 percent for commercial construction (e.g., shopping plazas), at 7.5 percent for public residential construction (e.g., housing projects), at 7.5 percent for educational construction, at 10.5 percent for water and sewage construction, and at 13.0 percent for highway construction (7).[1]

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1 - Underlined numerals in parentheses are references in Appendix A.

It is evident that increasing construction costs involve a large outlay of public and private funds. Much of the increased costs can be directly attributed to the declining availability of sand and gravel. Figure 1 illustrates how usage patterns in the region have varied in recent years.

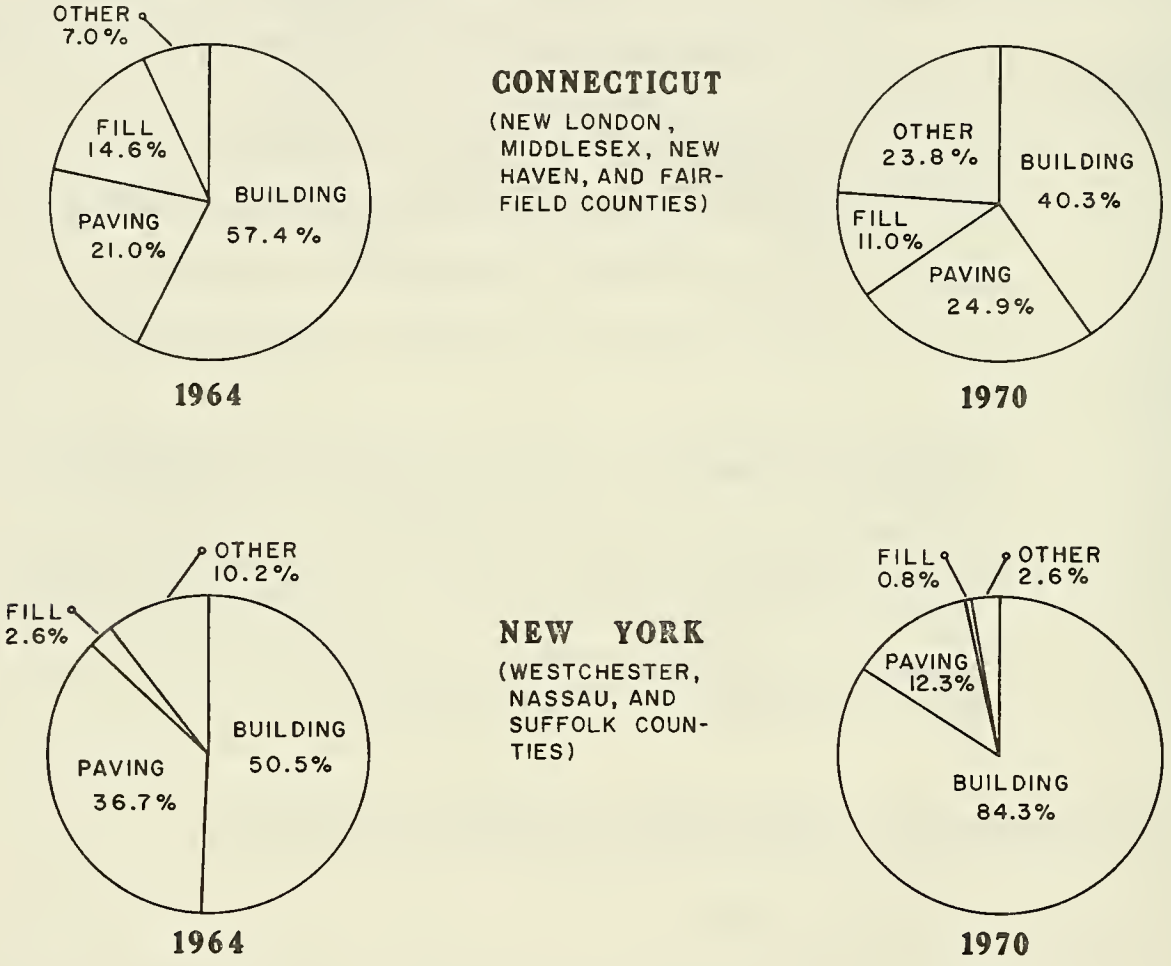

Figure 1. Sand and gravel use, 1964 and 1970. "Other" includes moulding sand, railroad ballast, and miscellaneous.

2.2 Importance of stone

Crushed stone in the area is produced from limestone, granite, basalt, and quartzite. It is used primarily as concrete and bituminous aggregates. Dimension stone is cut, shaped, or selected in specific forms for use in both interior and exterior parts of buildings, curbing, paving, and monuments. Limestone, granite, marble, sandstone, basalt, diabase, and diorite are

all used for dimension stone and are found in the area. Figure 2 illustrates the usage pattern in 1970.

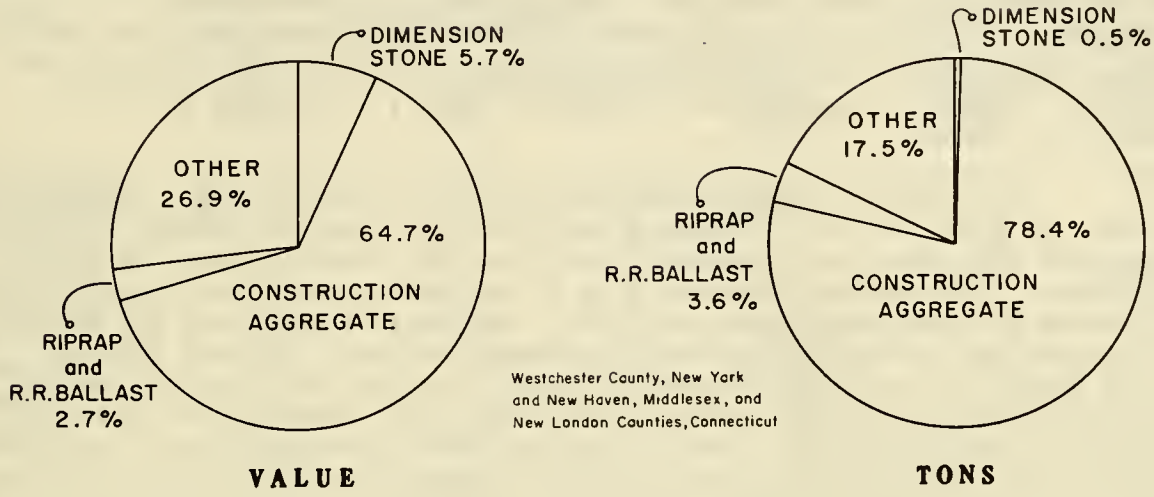

Figure 2. Value and quantity of stone by end use in 1970. "Other" includes agricultural fertilizer, glass, abrasives, terrazzo, and miscellaneous.

2.3 Other minerals

Clay is produced in the study area principally for heavy building brick. Mining activity in the region has not always been confined to the major minerals produced today. Many inactive mines, quarries, and mineral prospects have been described in literature dating from early settler days. In Connecticut, bismuth, copper, iron, kaolin, lead, and tungsten have been mined or prospected. Some stone quarries have operated in Westchester County within the confines of the study area, and in the very early days Long Island provided magnetite-rich beach sands for a forge in Connecticut.

2.4 Projected demand

No significant substitutes appear likely for such basic construction materials as sand, gravel, and stone. The Bureau of Mines has estimated that the annual growth rate in demand for sand and gravel in the United States will increase between 3.9 and 4.7 percent a year through the years 1970 to 2000. This projection was based on anticipated requirements for individual end uses of the materials (5). Average per capita consumption (production is one measure of consumption) of sand and gravel in the United States increased 130 percent from 1.79 tons in 1940 to 4.12 tons in 1959. It increased an additional 13 percent since then to 4.64 tons in 1969. In 1969, per capita production (apparent consumption) in Connecticut, New York, and New Jersey was

well below this national average. It was 2.20 tons in New York, up 31.7 percent over 1959; 2.94 tons in Connecticut, up 56.3 percent over 1959; and 2.85 tons in New Jersey, up 55.7 percent over 1959. The increases between 1959 and 1969 may in part be due to a better canvass of production. Nevertheless, these rates are indicative of increasing demand for sand and gravel. Apparent per capita consumption in the LIS region may be lower than the trends established on a State or national level, but demand is still expected to increase.

The report, "Long Island Sand and Gravel Mining" (12), prepared by the New York State Office of Planning Coordination, projected demand for Long Island sand and gravel to be nearly 14 million tons annually near the end of the century. This was not internal Long Island demand, but a projected demand requirement for the entire marketing area. Projections indicated 454 million tons of sand and gravel will be needed between the years 1966 and 2000 to satisfy demand in the primary marketing area: New York City, Nassau County, and Suffolk County; and the secondary marketing area: Westchester County, New Jersey, and Connecticut. The projections were based upon future population estimates and the calculation that per capita demand would be stable near the city and rise appreciably in the rapidly growing outer areas like Suffolk County. If population increases were the only gauge, annual demand for the LIS region as a whole would indeed drop in the future. In the population projections adopted by the Long Island Sound Regional Study, population growth in the region is expected to average only 85,000 annually over the next 50 years. This is a decided drop from the past 20 years when the LIS region population doubled by adding an average of 120,000 new residents a year. Modifying these population growth perspectives are probable increases in per capita consumption by the established population brought about by other trends, such as rising income, commercial buildings, and redevelopment.

Demand projections prepared by the U.S. Bureau of Mines for this study are presented in table 1. The entries were derived by multiplying future population, as projected by the U.S. Bureau of Economic Analysis (Series E), by 2.16 for sand and gravel and 0.79 for stone. These factors are the mean annual production in tons per capita for the area as a whole in recent years. The population and production figures relate to the entire areal extent of seven of the nine counties in the LIS region. Bronx and Queens demand projections, although not indicated in table 1, are included in the cumulative subregion demand figures in Appendix E.

TABLE 1. PROJECTED ANNUAL DEMAND
(in million short tons per year)

County	Sand and Gravel			Stone		
	1970 Production	Projected Demand 1990	Projected Demand 2020	1970 Production	Projected Demand 1990	Projected Demand 2020
New London	0.5	0.6	0.8	a	0.2	0.3
Middlesex	.4	.4	.5	a	.1	.2
New Haven	1.2	2.0	2.4	a	.8	.9
Fairfield	.5	2.2	2.7	b	.8	1.0
Westchester	.1	2.3	2.6	a	.9	1.0
Bronx	.0	c	c	0	c	c
Queens	.0	c	c	0	c	c
Nassau	4.5	3.7	4.0	0	1.3	1.4
Suffolk	1.8	4.8	7.8	0	1.8	2.9
Total	9.0	16.0	20.8	4.3	5.9	7.7

a. Data withheld to avoid disclosing individual company confidential data; included in "Total".

b. Less than 50,000 tons.

c. Not estimated; not included in "Total".

3.0 WHAT REQUIREMENTS MUST BE MET TO SATISFY THE DEMAND?

To satisfy a large sustained demand for sand, gravel, and stone, the major requirements are as follows:

Geological. Material of acceptable quality must be available in nature. Geological requirements present no problems in the LIS region.

Socio-environmental. Local zoning, ordinances, and public opinion must allow the material to be extracted. Once a site is built on, it is no longer available for mining. While the material is being produced, there must be acceptable controls on ecological impacts, noise, dust, visual quality, wear and tear on local roads, and safety. Upon the completion of the excavation, the area must be restored to a desirable condition. Socio-environmental requirements present the greatest limitation to supply. They have reduced the availability of the study area's most naturally abundant materials to a point of rapidly approaching crisis.

Locational. Because of the dominant effect of transportation on costs, available high-bulk materials of low unit value must be located at or very near the demand --- or both source and demand must be located very near a port to take advantage of low cost water transportation. As will be seen later, locational requirements will present severe problems.

4.0 WHAT IS THE CAPACITY OF THE REGION TO SATISFY THESE REQUIREMENTS?

4.1 Geologic background

The Long Island Sound Region is blessed with a natural abundance of sand and gravel. Figure 3 shows these major deposits. The physiography of the region is largely a consequence of the last major geologic event which took place in the region 14,000 to 20,000 years ago. During this period, the last

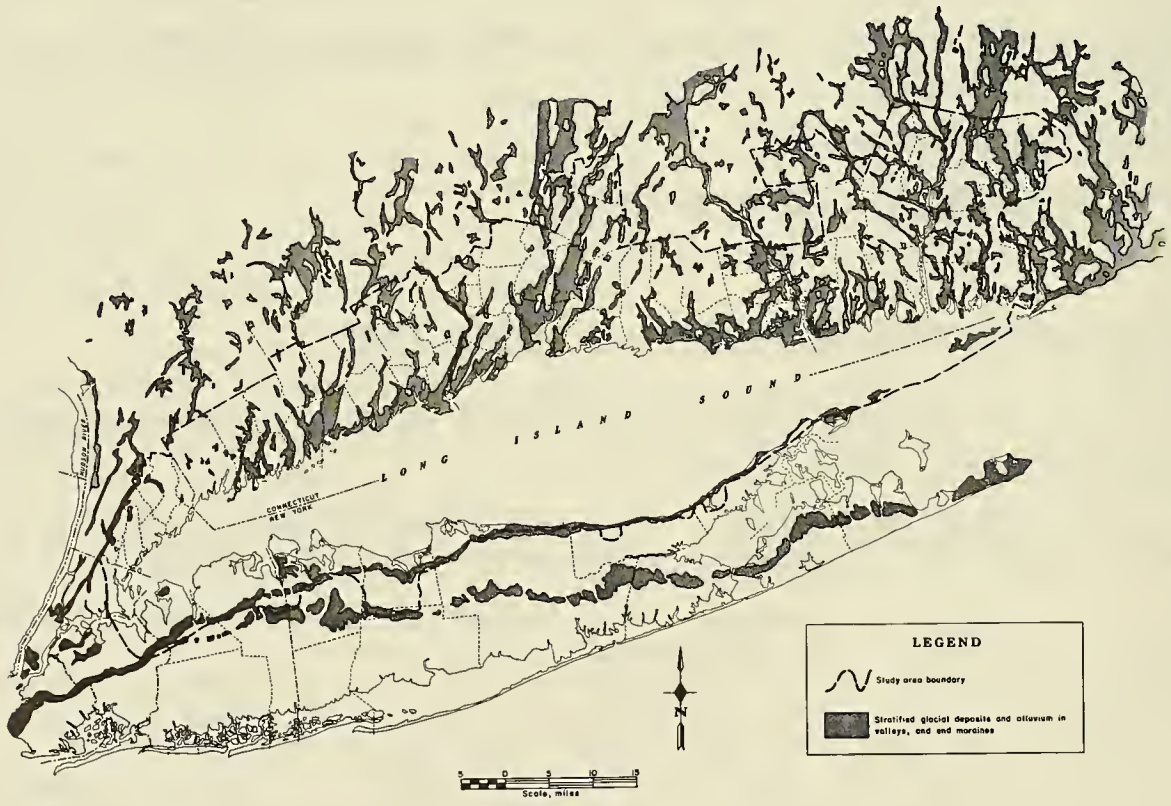

Figure 3. Major sand and gravel resources in the area surrounding Long Island Sound. Data Source: United States Geological Survey.

continental ice sheet advanced to the vicinity of Long Island from its origin in the north. Large quantities of sand and gravel, carried and pushed by the ice, were deposited and spread by glacial streams to cover nearly the whole of Long Island. Prevailing warmer climates caused the ice to melt and retreat to the north. Twice the glacier paused in its retreat and deposited two conspicuous east-west trending lines of hills on Long Island. These features, called terminal moraines, are composed of coarse gravels and sand.

The moraines contain the most valuable sand and gravel deposits on Long Island, although almost any piece of ground is likely to be underlain by economically valuable deposits. In Connecticut the ice mass stagnated and melted. Numerous sand and gravel deposits were left as terrace or valley fill deposits, which are glacial, glaciofluvial, and glaciolacustrine in origin.

Stone resources in the region consist of bedrock. In many places, the bedrock is covered by Recent alluvium and material that was transported and deposited by the last ice sheet. Bedrock on Long Island is in places overlain by hundreds of feet of Coastal Plain silts, clays, sands, and gravels of the Cretaceous and Quaternary system and above these lie glacial deposits and Recent alluvium. Bedrock in the rest of the region consists mostly of highly metamorphosed crystalline rocks of volcanic, sedimentary, and igneous origin. An exception is south-central Connecticut, where sedimentary rocks consisting of shales, siltstones, arkose, and conglomerates of Triassic age are found. These rocks have been intruded by basalt and diabase of the same age. Basalt and diabase are considered important stone resources in Connecticut. Figure 4 depicts the location of the major types of stone resources in the LIS region. Rocks included are granitic rocks, basalt, diabase, marble, limestone, and dolomite.

The Continental Shelf off Long Island --- and off the entire east coast of the United States --- consists principally of sand with scattered deposits of gravel. The varied pattern in the Sound is depicted in figure 5, which is a highly generalized sediment distribution map compiled from existing data. In the eastern part of the Sound, the bottom is mostly sand with a little gravel. In the western part of the Sound, substantial fine grained material and organic matter are encountered. Subgranular materials on the bottom consist mainly of noxious organic silts having no known commercial value. Some attention has been given to the possible exploitation of heavy mineral ore separates, but in no instances are there known deposits of primary commercial potential. Seismic investigations have revealed the presence of large "sand waves" on the Sound floor. They are located principally north of the North Fork of Long Island. They have also been located off New London, the Connecticut River, New Haven, Bridgeport, and Norwalk.

4.2 Limitations on availability of the natural deposits

Mineral deposits occur at specific locations. This is one of many factors limiting mineral production. Existing state and Federal controls on mining allow the utilization of mineral resources, whereas local zoning often does not. Once zoning allows land to be put to a different use, there is

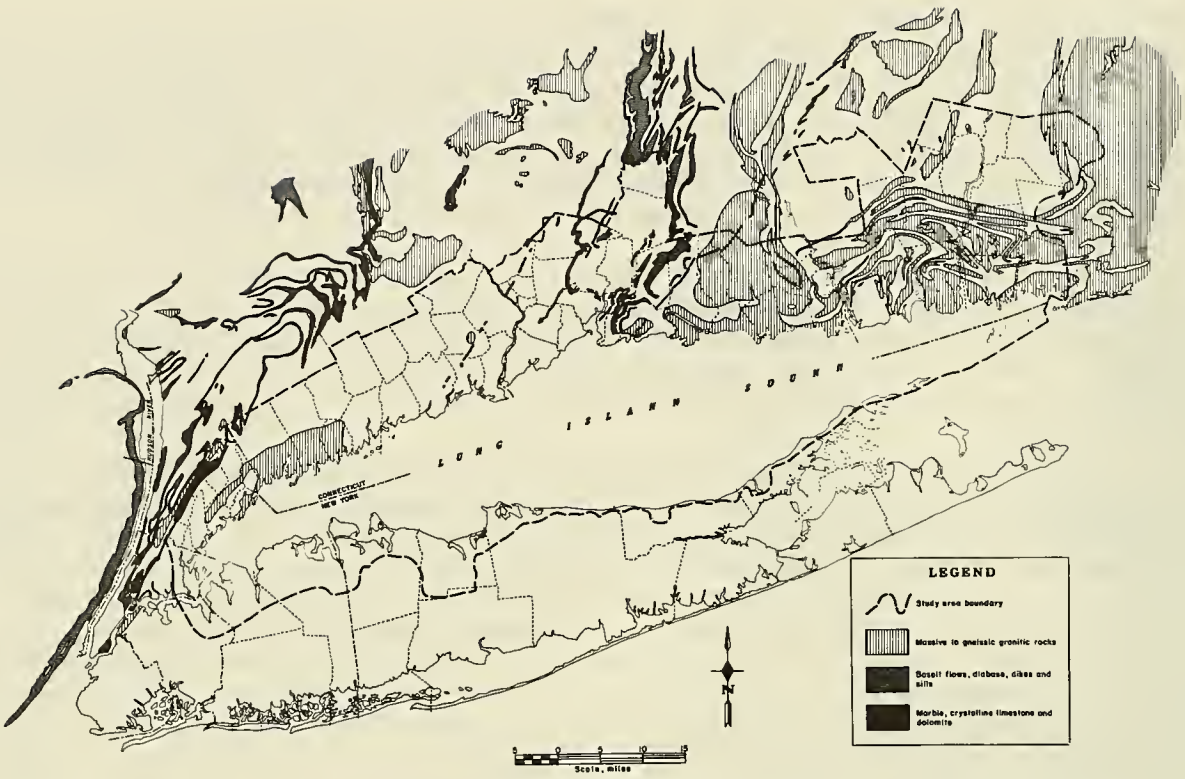

Figure 4. Major stone resources in the area surrounding Long Island Sound. Data Source: United States Geological Survey.

little chance to retrieve "lost" minerals. Problems existing in the region relate to the common mineral resources sand and gravel, stone, and clay. People through their own actions, are forfeiting the availability of their mineral resources.

Zoning. Most towns within the region have zoning regulations or ordinances which specifically regulate the extraction of mineral commodities: sand and gravel, stone, clay, fill material, and soil. Town ordinances differ in many aspects, but the majority of them include clauses which can be grouped into three categories: preoperating requirements, operating requirements and postoperating requirements. Preoperating requirements include a permit, public hearing or notice, an application fee, a performance bond, a detailed mining plan, and a reclamation plan. Operating requirements include setback, fencing, screening, slope control, excavation depth limits, dust control, drainage system protection, and curtailed operating hours. Postoperating regulations require the land to be reclaimed after operations cease. These items are commonly required: regrading, spreading topsoil to specific thicknesses, and replanting vegetation. Mineral producers can and do meet these requirements.

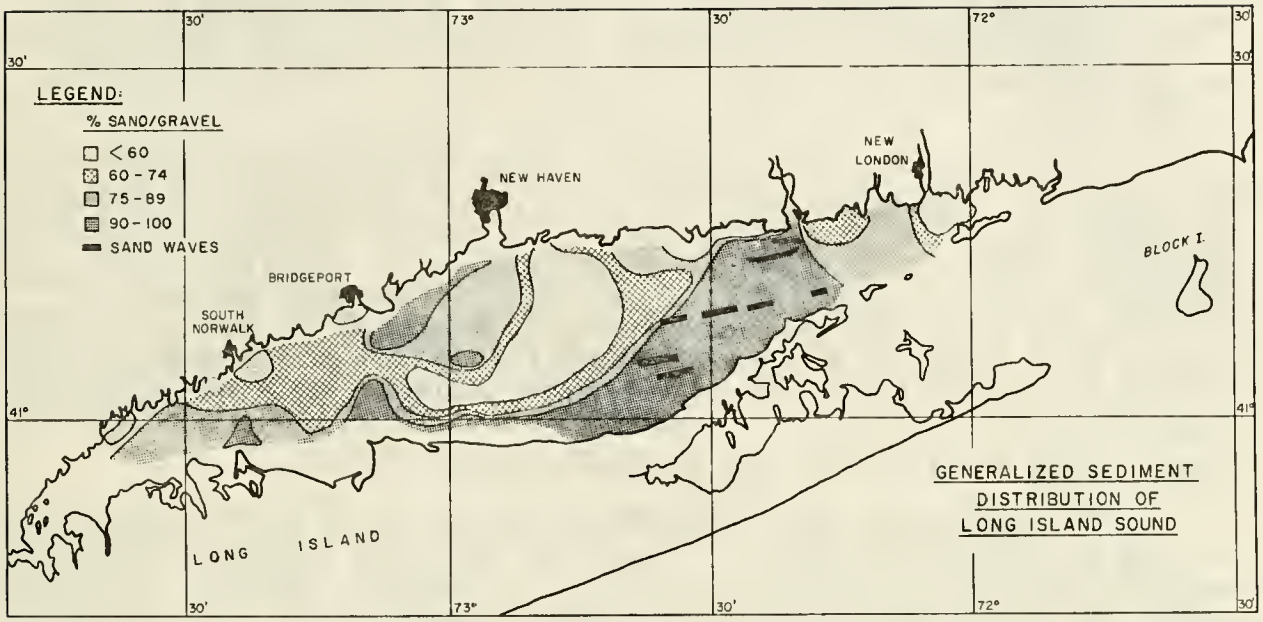

Figure 5. Generalized distribution of sediment in Long Island Sound. The percentages are the proportion of sand and gravel to total sediment. For example, the 75-89 percent zone includes 11-25 percent of silt and clays. The locations of the "sand waves" are taken from a figure in volume 81, number 3, March 1970 publication of the Geological Society of America Bulletin, entitled "Sub-bottom Study of Long Island Sound," by M.S. Grim, C.L. Drake and J.R. Heitzler.

Mineral supply problems may result from overly restrictive local zoning. Some towns have clauses within their ordinances which affect both the local consumer in that particular town and individuals in the entire region. The town of Harrison limits excavations to 1 acre. This is an unrealistic acreage for commercial production. The towns of Easton and Monroe have ordinances which include the statement, "No sorting, grading, crushing, or other machinery for the treatment of excavated material shall be maintained or erected on the premises from which permission to excavate and remove topsoil or subsoil materials may be granted". But, in most instances consumer demand requires processed material. This results in importing materials in order to meet construction specifications and high transportation costs occur. For example, costs of delivered washed sand tripled recently over 4 years in Greenwich and Darien. Ordinances in Stamford, Waterford, and Greenwich allow only simple screens, but specifications for certain types of construction require crushed or washed materials. Bethany allows no rock or stone mill crushers or quarries. Permits for excavation vary in length from 6 months to 5 years. Six months is an unrealistic time interval for commercial production.

Excavation depths or cuts are often limited to 10 feet. Economics often rule out mining deposits where this depth limitation is in effect. Local ordinances may be construed as affecting mineral extraction, although they do not specifically regulate mining. "Nassau County has not allowed a new sand and gravel operation in the past 10 years although theoretically the local laws permit it" (8).

The manner in which aggregate producers have operated in the past has created problems for the industry. Unreclaimed landscapes, dangerous operations, noise, dust, and heavy traffic have brought the public's wrath in the form of numerous regulations and areal restriction. Regulations are necessary and they alone do not rule out mineral extraction. Unreasonable public opinion is the most formidable threat. An example has been given of one property owner trying to prevent the start of a sand and gravel operation for an assumed dust threat, yet the property to be exploited was a low-lying swamp three-fourths of a mile downwind from the landowner's property (3). In the future, public hysteria will have to be countered with logic.

Land use and value. Competing land uses often preempt the most valuable sand and gravel deposits. Cemeteries are often located on these deposits for ease of digging (few boulders) and excellent drainage. Highways, sewers, and underground cables traverse deposit areas for the same reasons. Dwelling sites are preferably located on sand and gravel deposits, especially when climate indicates the necessity of basements. Water needs often preempt sand and gravel deposits because some contain excellent supplies of water. Local zoning laws, however, can be revised to permit sequential land use and wise utilization of mineral resources.

Land values are increasing in the region, but value alone will not be a serious threat to mineral extraction if the land has not been improved. Small operators though, may be adversely affected. Proper extraction methods and preplanned reclamation have been found to add value to the land. In Connecticut, condemnation awards by the State for sand and gravel reserves in the years 1963 to 1967 ranged from $375 per gravel acre or $0.03 per cubic yard to $8,775 per gravel acre or $1.37 per cubic yard (15). The higher award reflects proximity to the dense urban belt.

Federal and State controls. Federal or State agencies regulate worker health and safety, air and water pollution, and noise. Regulations required by local units of government have been described in the previous section. Mining will undoubtedly come under more legislation in the future because bills have been introduced on the Federal level in both the House and Senate to regulate surface mining. In 1974, the New York State Legislature passed, and the Governor signed into law, the Mined Land Reclamation Act. While the law is not scheduled to take effect until the Spring of 1975, its intent is clear: to encourage the orderly extraction and subsequent reclamation of mineral-bearing lands. Connecticut has conducted a preliminary investigation in the event Federal guidelines are proposed for surface mining.

Both Connecticut and New York have agencies which monitor air and water pollution according to standards set by the U.S. Environmental Protection Agency. Water pollution requirements are being met by the aggregate industry; most firms recycle some process water and make use of settling ponds for extraction of particulate matter. Records in Connecticut Water Compliance Unit's files from 1960 to the present listed only one mineral producer in the study area as having a serious water-related problem. This occurred in 1967. All other inspections termed problems as minor or nonexistent. Prolonged rainy spells could cause silt runoff problems in isolated instances. Control of particulate emissions in air and fugitive dust have been a greater problem, requiring investment by the industry in sprinkling systems to meet air quality standards. Most producers now control dust by a sprinkling system. Many have paved or oiled roads leading from the plant site, which help to further alleviate dust. Both Connecticut and New York allow some tax credits for air pollution control equipment.

All firms in interstate commerce come under Federal noise level regulations (Walsh-Healey standards) since the Occupational Health and Safety measure went into effect in April 1971. Interim criteria were set by the Department of Health, Education, and Welfare. Connecticut Public Act 762, effective on January 1, 1973, also sets allowable noise levels. The Mining Enforcement and Safety Administration (formerly a part of the U.S. Bureau of Mines) is responsible for health and safety inspections of mineral producers under the Federal Metal and Nonmetallic Mine Safety Act of 1966. Inspections of quarries and sand and gravel operations started in July 1970.

Limitations in Connecticut. The Connecticut Department of Transportation, Bureau of Highways, has long been concerned with the availability of natural aggregate materials for highway construction and maintenance. In 1960, a Construction Aggregate Availability Study was initiated through planning and research funds provided by the Federal Highway Administration. Three reports have been published, 1966 (3), 1970 (17), and 1972 (18) which outline potential sand and gravel resources for the entire State.

Data from these reports were compiled and are presented in figure 6. Resources for the Connecticut towns in the study region are listed in Appendix C. Eleven towns have no potential sand and gravel resources. Existing land use, local zoning, and depleted reserves have contributed to a shortage of available reserves in these towns. Not surprisingly, figure 6 depicts the most abundant sand and gravel resources in the least urbanized areas where land use conflicts are fewer.

As early as 1966, when the first State report was published, it was predicted that naturally-occurring aggregate materials would be unavailable within 20 years. The report covered 38 towns in northwestern Connecticut, one of the lesser populated areas of the State. Trends indicated that about 5 percent of potential aggregate resources would be eliminated annually due to social and economic factors resulting from increasing population. This figure did not reflect depletion of reserves caused by mining.

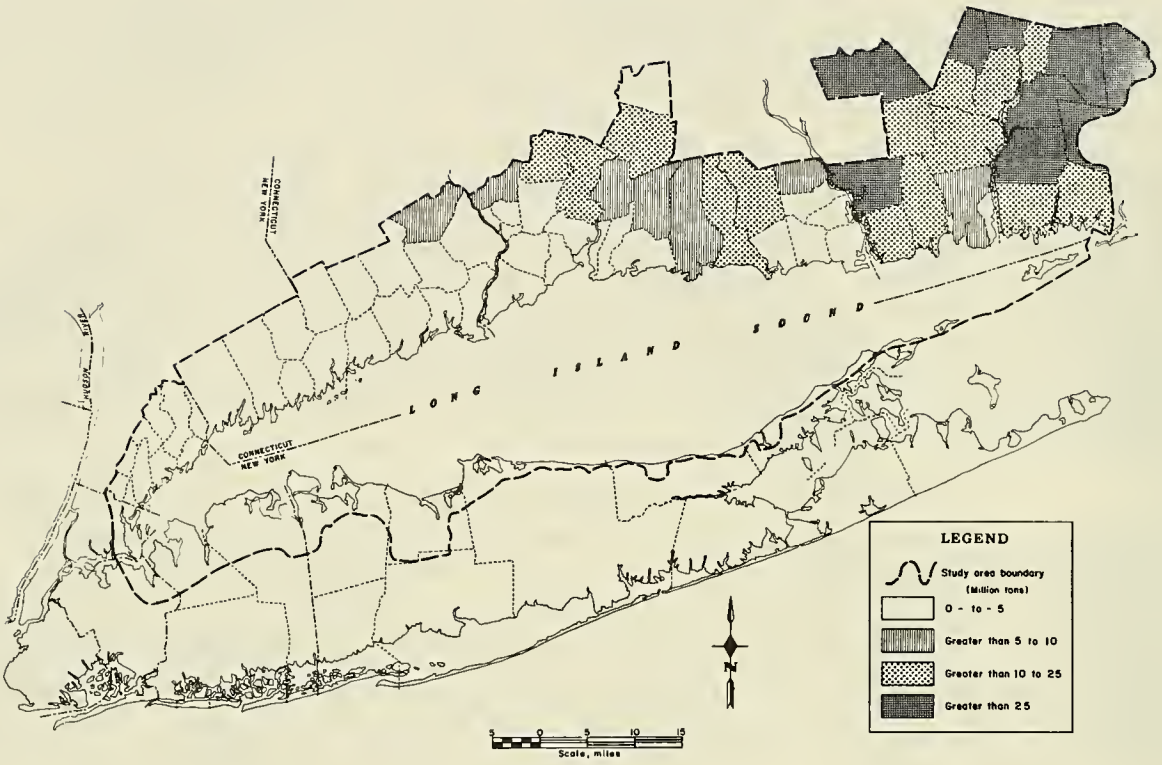

Figure 6. Resources of sand and gravel by town in Connecticut portion of Long Island Sound study area. Data Source: Connecticut Department of Transportation.

A paper presented at the Fifth Forum on Geology of Industrial Minerals in 1969 has further stressed declining sand and gravel resources in Connecticut. In conclusion it states, "...one mistake, in not planning the exploitation of sand and gravel resources, should be enough" and recommended that Connecticut should reserve adequate sources of crushable rock to meet future demand for aggregate materials (15).

Built-up lands in Connecticut in 1970 totaled 507,000 acres. This is about a sixth of the State's land area and is an increase of 64 percent since 1960 (4). Probably much of the increase has preempted sand and gravel deposits because of their favorable drainage and construction aspects. If this rate were fully applicable to sand and gravel resources as mapped by the State of Connecticut in the LIS region, they would be nearly all preempted by 1987.

Limitations in New York. Available reserves of sand, gravel, and stone in Bronx and Queens Counties are nil; there has been little or no reported production of sand, gravel, or stone there for many years. Nassau

and Suffolk Counties have no stone, but they have abundant natural deposits of sand and some gravel. Available reserves are a different matter, and they alone are the basis of continuing production. Total sand and gravel reserves held by operating companies in 1965 were estimated at about 162 million tons (6). With production ranging between 6 and 10 million tons a year since then and with very few new permits being granted, the available reserves are apparently being consumed at an alarming rate. To confirm or modify this perspective, field studies and industry cooperation will be necessary.

Availability in Long Island Sound. The rapid depletion of land sources of granular materials needed for construction purposes justifies serious consideration of exploiting abundant nearshore deposits. Basic constraints on mining in the Sound include (1) limitations on the types of areas available, (2) environmental and sociolegal concerns, and (3) competition for multiple use. They are all interrelated. For example, a major part of the Connecticut shore west of the mouth of the Connecticut River is unavailable for mining out to the 40-foot depth because it is set aside by law for leased oyster beds. Below that depth, ordinary dredges cannot be used and the cost of dredging increases substantially. A tradeoff involving legal zoning would be necessary for mining to take place without going to special dredging equipment. Present feasible depth limits for commercial equipment are in the general order of 200 feet. Dredging close to shore can cause physiographic changes to the shoreline. A rule of thumb policy has been to forbid dredging within one-half mile of a bathing beach. The policy is based on the theory that a depression above the elevation of the wave base (depth below which waves do not normally affect the bottom) would be reflected all the way to the shore resulting in shoreline recession. The wave base would be in the 20- to 30-foot depth range. Beach slopes along the Sound are so gentle that the restriction of one-half mile from shallow excavations appears reasonable. Deeper excavations would require even greater beach clearance. Probably the most significant environmental consideration is the percentage of organic silt. Material containing substantial silt must be washed to produce sizes suitable for most construction or beach fill purposes. A major washing operation would introduce concern about turbidity, excessive release of nutrients, or anoxic conditions, all of which are associated with the fines. However, it should be rather easy to avoid these problems and run a very clean operation by using the very large indicated quantities of clean sand, particularly those found in the eastern end of the Sound.

4.3 Production

Figure 7 shows the nine counties in which the study area is located. Together they produced 9.0 million tons of sand and gravel in 1970. As figure 7 indicates, Nassau County accounted for half of the production and production in Queens, the Bronx, and Westchester was either zero or insignificant. Stone production in 1970 totaled 4.3 million tons and was confined to four counties: New Haven, Middlesex, New London, and Westchester.

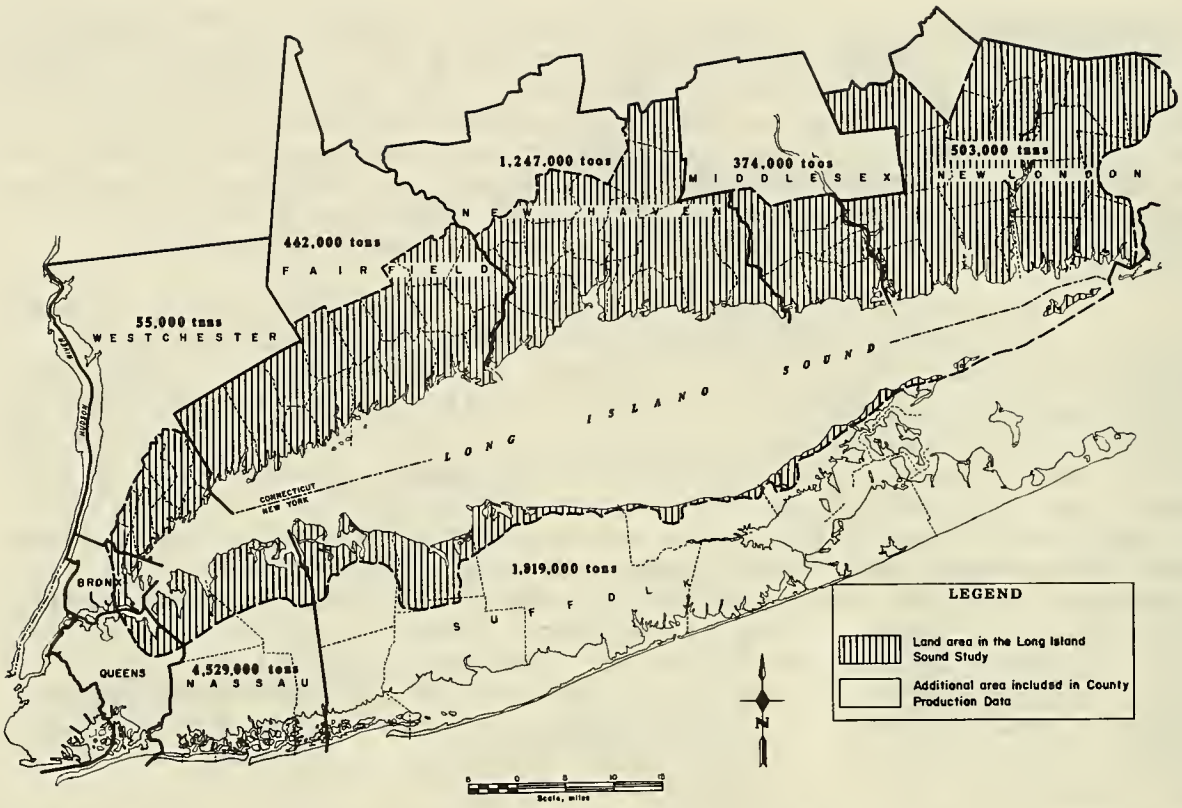

Figure 7. Production of sand and gravel by county in 1970.

Table 2 displays production as reported to the U.S. Bureau of Mines in recent years. Note that sand and gravel production has been steadily diminishing and that the value per ton has risen rapidly since 1968. Stone production has been increasing steadily. Much of the increase is probably due to crushed stone replacing gravel production. Some discrepancy exists as to the amount of production occurring on Long Island. The report, "Long Island Sand and Gravel Mining," estimated sand and gravel production to be 40 percent higher for the years 1964 through 1966 than production reported to the U.S. Bureau of Mines. Future studies will need industry cooperation so that reliable estimates can be made of available reserves. Only then can the magnitude of the mineral supply problem be accurately portrayed.

Appendix D contains a listing and a map of active sand and gravel plants, quarries, and plants producing clay products.

Marine production. Significant quantities of marine sand and gravel have not been dredged since 1965. In an earlier period, however, 1945-65, about 7 million tons of sand were dredged from the Sound. About three quarters of this total were used in Connecticut mostly for major projects such as fill for the Connecticut Turnpike and a powerplant at Bridgeport. Most of the sand dredged on Long Island resulted from navigation projects.

TABLE 2. PRODUCTION IN THE NINE-COUNTY AREA

Year	Sand and Gravel			Stone (crushed & dimensioned)	
	Million Short Tons	Value ($ million)	Value Per Ton	Million Short Tons	Value ($ million)
1964	14.2	14.8	1.04	3.2	5.7
1965	12.3	13.6	1.10	2.9	5.3
1966	12.2	13.0	1.07	2.5	4.9
1967	11.5	12.2	1.06	2.6	5.7
1968	11.1	12.2	1.10	3.2	6.5
1969	11.2	13.3	1.18	4.0	8.2
1970	9.0	11.6	1.30	4.3	8.7

In dredging construction materials from the Sound, some production problems must be overcome. The required half-mile offshore clearance tends to rule out hydraulic dredging in the vicinity of beaches. Bottom-dump scows can be loaded with clean sand and unload in a sump near shore for rehandling to shore by hydraulic pipeline. A seagoing hopper dredge with shore pumpout facilities seems to offer the most satisfactory method at present. The material is pumped up into the hold of the dredge. The dredge transports it to a raft moored about a half mile offshore. The material is then pumped through a submerged pipeline from the raft to the shore. One problem is financial. Some sectors of the dredging industry are understandably reluctant to commit venture capital to a major operation without a very high degree of certainty that potential environmental and legal issues will not later abort their efforts.

Water requirements. According to a nationwide study by the Bureau of Mines in 1962, sand and gravel producers used 508 gallons of water per ton of crude material handled. Of this, 325 gallons were new water, 183 gallons were recirculated and 17 gallons were consumed, mainly by evaporation. Crushed stone producers used 109 gallons of water per ton of crude material handled. Of this, 83 gallons were new water, 26 gallons were recirculated, and 6 gallons were consumed. It is assumed that the national average for water use has not changed significantly since 1962 and that mineral industry water use in the LIS region does not differ from this average.

Mineral industry developments. In this highly competitive industry, production costs have been reduced by new methods of mining, processing, and handling materials.

Mine blasting techniques have been improved to such an extent that quarries are operating within 200 feet of their nearest neighbors. Even large mining operations which drill and blast 8 million tons of ore per year can operate within 800 feet of a dwelling. One dimension stone producer in Connecticut uses jet piercing equipment which utilizes compressed air and fuel oil to cut desired sizes of stone blocks.

Revolutionary developments are occurring in material processing. New York Trap Rock, a subsidiary of Lone Star Industries, Inc., Greenwich, Conn., is installing a plant near Nyack, N.Y., to reduce stone to sand through a new process of tension shock shattering with steam. Considerable savings are projected, which could mean reduced prices to the public as well as having a source of sand-sized material available when natural reserves of sand are depleted or preempted (19). Stone producers in Connecticut are making stone sand using conventional equipment.

Improved materials handling methods have been developed. Computers are now being used to control sand and gravel plant operations. Unit trains are being used to transport materials and pipelines are moving stone in slurry form. In the future, sand may also be transported in slurry form.

Land reclamation. Reclamation techniques have improved to such an extent that land values have increased as much as 10 times their value before mining (11). Innovative uses of mined lands have been developed. Underground quarries have been converted into profitable commercial warehousing operations. Pennsylvania has a commercial mushroom growing operation in a worked out mine. Connecticut has ball parks and sanitary landfills developed on mined lands. Many residential dwellings now stand on tracts from which mineral commodities have been extracted.

It was not always thus. Before local ordinances and enlightened self-interest required reclamation, many areas were abandoned. They remain conspicuous scars, especially in areas of encroaching urbanization. Many of the confrontations between the public and current aggregate producers are due to these orphan lands. The public retains the image of these lands even though producers in LIS are currently practicing reclamation to the degree required by local ordinances. It is also likely that the producers currently operating are not responsible for the orphan land.

The mining industry is now aware that in order to keep operating, certain steps need to be taken during the mining operation to protect the environment and that mined lands need to be reclaimed for future use.

The National Sand and Gravel Association has for many years been aware of the conflicts between urbanization and the aggregate industry. Numerous reports outlining rehabilitation practices have been published for distribution to mine operators and planners. A discussion of the concepts presented in these reports would become a volume in itself; some of the titles (2), (9), (10), (13), (14) have been listed in Appendix A to acquaint the public and planners with the abundance of existing reclamation literature. Numerous ideas have been presented on the use of mined lands as residential areas, country clubs, golf courses, campsites, skeet ranges, grass farms, and auto racing tracks. The report "Long Island Sand and Gravel Mining" (12) contains illustrations of acceptable reclaimed mine areas on Long Island.

The future use of mined lands requires imaginative planning backed by legislation such as New York's Mined Land Reclamation Act to provide regional or statewide standards rather than the current plethora of conflicting local regulations. The legislation could provide for a continuing supply of locally available aggregate materials as well as environmental enhancement of the site in accordance with a community master plan. Economic and environmental considerations here should be able to reinforce each other, not compete.

4.4 Transport

When aggregate resources close to the markets cannot be used, economic and environmental problems shift from land use to transportation. As truck, barge, and rail traffic increase, costs rise rapidly, more energy is consumed and congestion problems are aggravated. The transportation mode employed greatly influences the delivered costs. For example, if the price of a ton of sand, gravel, or crushed stone is $1.25 a ton, f.o.b. plant, the cost will double about every 8 to 12 truck-miles, or 50 railroad-miles, or 125 barge-miles. Normally the short hauls are by truck. For long hauls, several modes are used. The usual sequence is (1) by truck or conveyor belt to port or rail spur, (2) by barge or rail to receiving port or rail spur, and (3) by truck to final destination. The last leg is often in the form of ready-mix concrete or asphaltic hot mix.

Truck. As indicated above, trucks are the sole means of delivery for short hauls. They are also usually the initial and final mode for long hauls. Truck movements vary from day to day, and development patterns would be a study in itself. Connecticut "bid lists" give indications of individual producer and distributor capabilities and marketing areas by trucks, but, as only two commodities are involved, washed sand and screened sand, distribution patterns are not conclusive. Haul rates reported for Connecticut in March 1973 were about $0.86 per ton for any distance up to 4 miles and $0.10 per ton-mile thereafter. Nine million tons of sand and gravel were moved by truck in the Nassau-Suffolk area and nearby points in Queens and the Bronx in 1966. A truck survey conducted in 1963 reported the longest haul on Long Island to be 30 miles. The average haul was 6 miles (12).

Barge. Since the LIS region is well endowed with natural waterways, barge has become the primary mode for long-distance hauls. Average cost is about 1 cent per ton-mile in the 50 to 100-mile range. The principal shipping ports for sand and gravel are Hempstead Harbor, Manhasset Bay, and the New Jersey ports. The principal shipping ports for stone are the Hudson River ports above New York City and Pine Orchard, about 10 miles east of New Haven. Figure 8 locates the principal receiving ports. Figures 9 and 10 provide a closer look at shipments along the western tip of LIS. Currently the region's two major sand and gravel ports are Hempstead Harbor and Manhasset Bay. Figure 11 summarizes shipments, mostly of sand, from these two ports in recent years. The distribution of shipments in this figure follows the classification of the Corps of Engineers --- local, internal, and coastwise. Local movements are those within a port; here they include

Figure 8. Ports receiving sand and gravel and stone in 1970. Data Source: Department of the Army, Corps of Engineers.

movements between lesser ports in the "Greater Port of New York." Internal movements are those on inland waterways; here they include movements starting or ending on the Hudson River. Coastwise movements are those over an ocean; here they include movements over the Sound. In 1965-66, New York City received 54 percent of the sand and gravel barged from Long Island ports. New Jersey received 27 percent and Connecticut 10 percent. Westchester, Hudson River ports north of New York City, and other Long Island ports shared the remaining 9 percent (12).

As figure 8 depicts, all ports in the western half of the Sound receive either sand, gravel, or stone. Figure 12 depicts recent receipts in selected Connecticut ports. At Norwalk, a distributor stockpiled aggregate; that accounts for the large tonnage received at this port in 1969. Figure 13 depicts recent receipts in selected New York ports. All told, northern Long Island ports received more than 1.8 million tons of sand, gravel, and stone in 1970. Most of it was stone.

It should be stressed that the flow of material between ports changes from year to year. For example, Northport Bay shipped millions of tons of sand and gravel during the years 1960-68, but no tonnage was reported

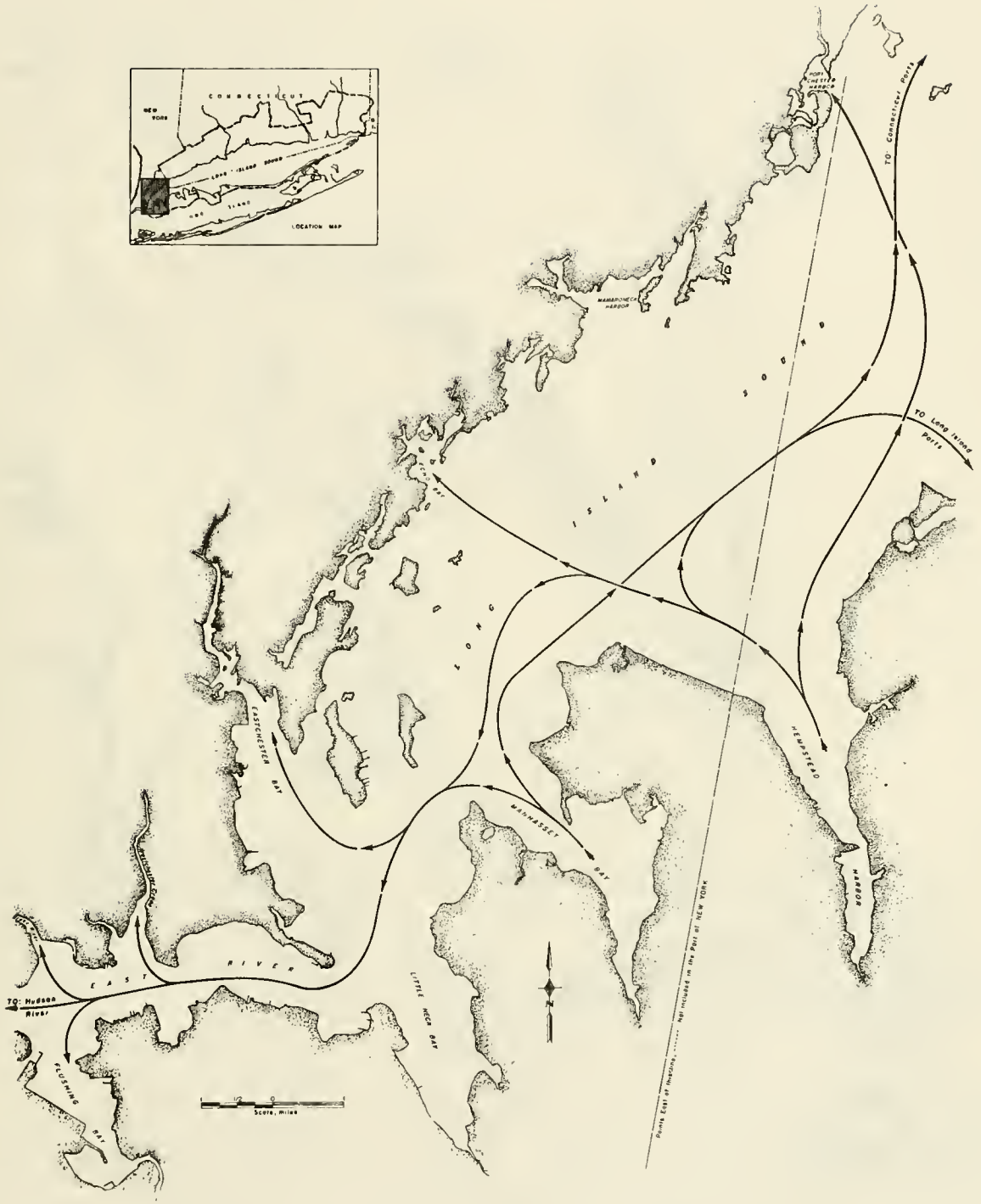

Figure 9. Barge movements of sand and gravel in the "Greater Port of New York" area, 1970. Data Source: Department of the Army, Corps of Engineers.

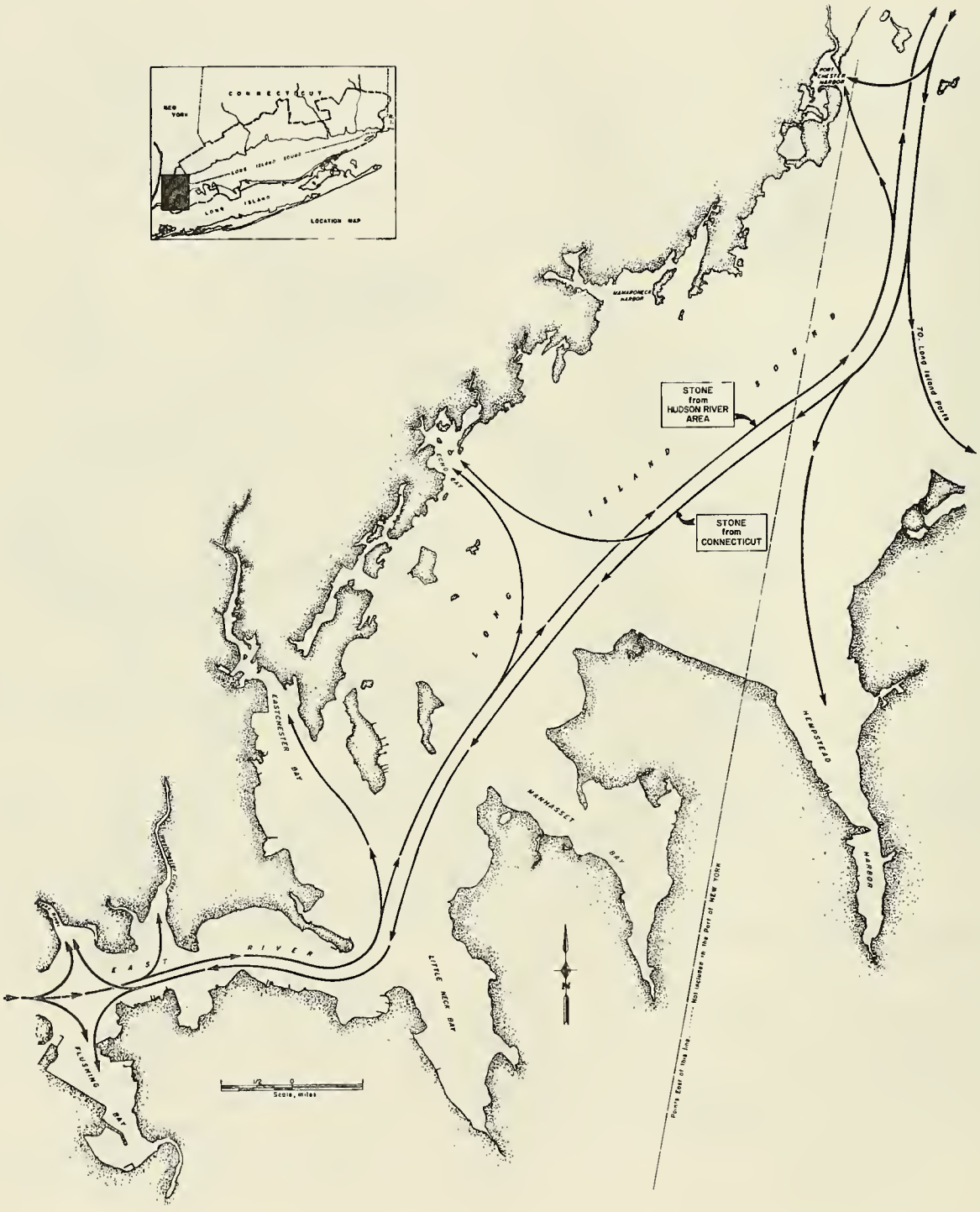

Figure 10. Barge movements of stone in the "Greater Port of New York" area, 1970. Data Source: Department of the Army, Corps of Engineers.

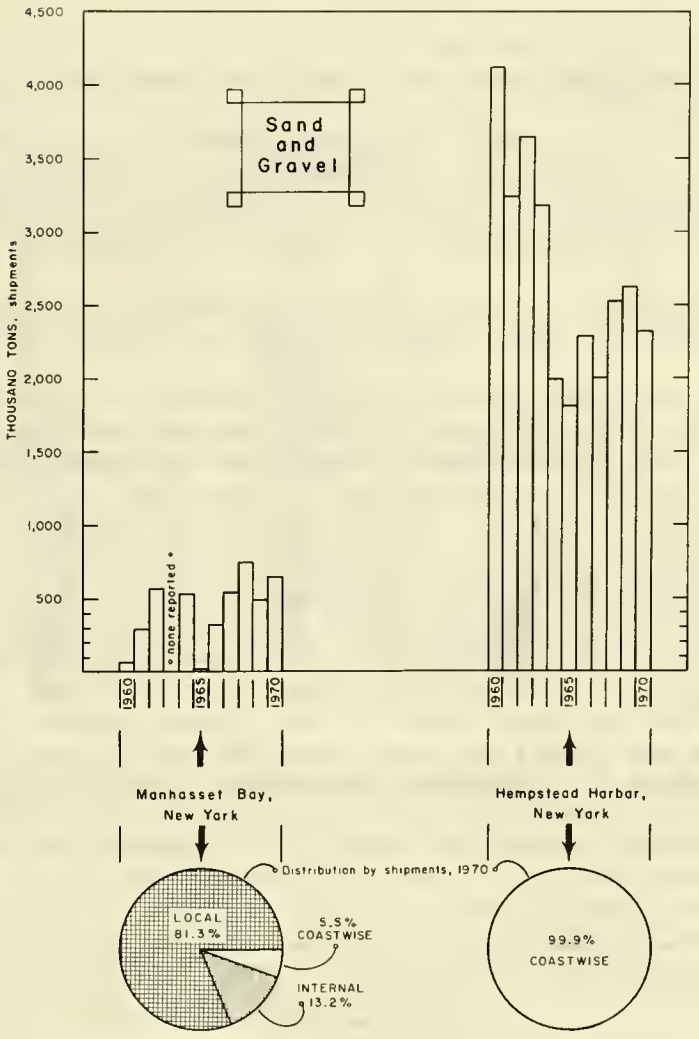

Figure 11. Sand and gravel shipments from selected New York ports, 1960-70. Data Source: Department of the Army, Corps of Engineers.

shipped from this port in 1969 and 1970. Some sand and gravel destined for LIS ports originates in New Jersey. Considerable quantities may come from there in the future should Long Island operations cease. One New Jersey firm is reported as having the capability of producing 1,000 tons per hour.

Rail. In 1966, rail was the primary transportation mode for less than 2 percent of the aggregate material produced on Long Island. Average cost per ton-mile was reported as 2.6 cents, not including the loading and unloading costs at intermodal points. The longest rail haul reported in the study region was nearly 100 miles. It involved crushed stone transported from Connecticut to the Greater New York area (6). One major aggregate producer in Connecticut uses a unit train to haul material from an inland plant to the shore of the Sound for barge shipment.

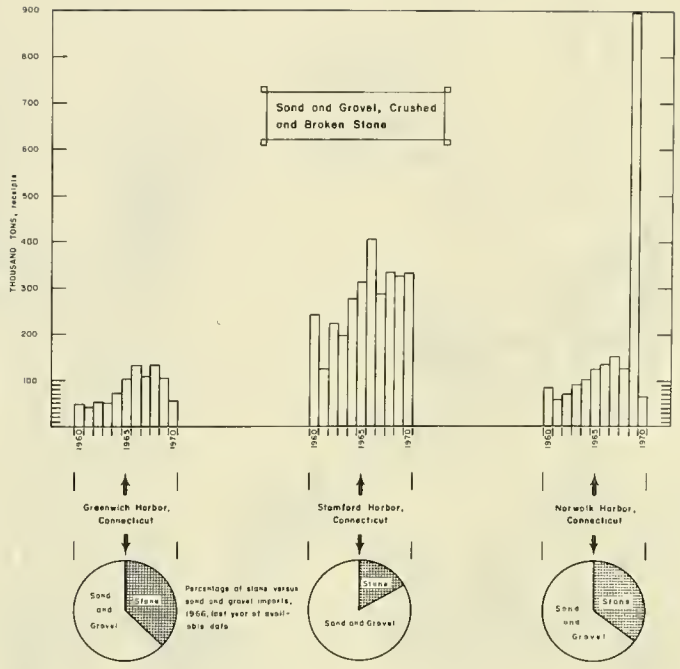

Figure 12. Sand and gravel and stone receipts for selected Connecticut ports, 1960-70. Data Source: Department of the Army, Corps of Engineers.

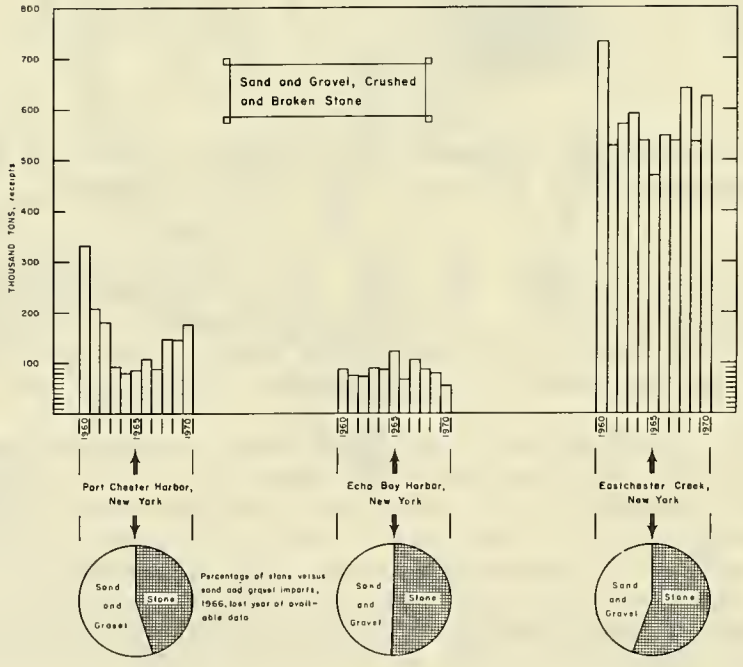

Figure 13. Sand and gravel and stone receipts for selected New York ports, 1960-70. Data Source: Department of the Army, Corps of Engineers.

4.5 Costs

In preceding sections it has been shown that for sand and gravel and stone -

- Geologically, the LIS region is rich.
- Production costs are generally constant.
- Available reserves near markets are rapidly being depleted.
- Transportation distances are increasing rapidly.

The last two related situations plus long-term inflationary trends are responsible for a sharp increase in overall costs in recent years.

The State of Connecticut's purchasing department distributes contract award listings for sand and gravel to agencies within the State. These contain information which aid "in depth" studies of the sand and gravel industry in Connecticut, and they are one of the best indicators of local consumer costs. According to these listings, average bid price for sand and gravel "in bank" in the State of Connecticut increased from $0.38 per ton in 1967 to $0.66 per ton in 1971, a 74-percent increase caused in part by increasing land values and declining reserves. In 1971, producers who offered "in bank" sand and gravel valued gravel up to five times the amount bid for sand. Some towns within the Connecticut portion of the study area have little or no reserves of sand and gravel and "in bank" materials are not available.

The average bid price for processed sand in stockpiles (screened or washed) in Connecticut increased from $0.80 per ton in 1967 to $1.25 per ton in 1971, a 56-percent increase. The latest nationwide figures published by the Bureau of Mines (1970) for the average value of sand and gravel sold or used by producers, f.o.b. plant, was $1.18 per ton. Table 2 shows how the value of processed sand and gravel, f.o.b. plant, increased between the years 1964 and 1970 in the nine-county area. Figure 14 shows the reported dollar value per ton, f.o.b. plant, by county in 1970.

Plant-site stockpiles of processed sand and gravel are nonexistent in some towns within the LIS region because of restrictive local zoning. Transportation costs are directly reflected in the prices bid for delivered processed sand. For example, because of low availability, Fairfield County prices, f.o.b. plant, were the highest in the study area ($2.03 a ton per figure 14). Delivered costs in Greenwich and Darien, both located in this county, are about three times the high countywide level.

Figure 15 shows how costs in those two towns have risen in recent years in comparison with the state average and costs in Colchester, a rural town representative of those where sand and gravel extraction is allowed.

In a large scale continuous operation, the cost of marine sand should be competitive with the cost of terrestrial sand.

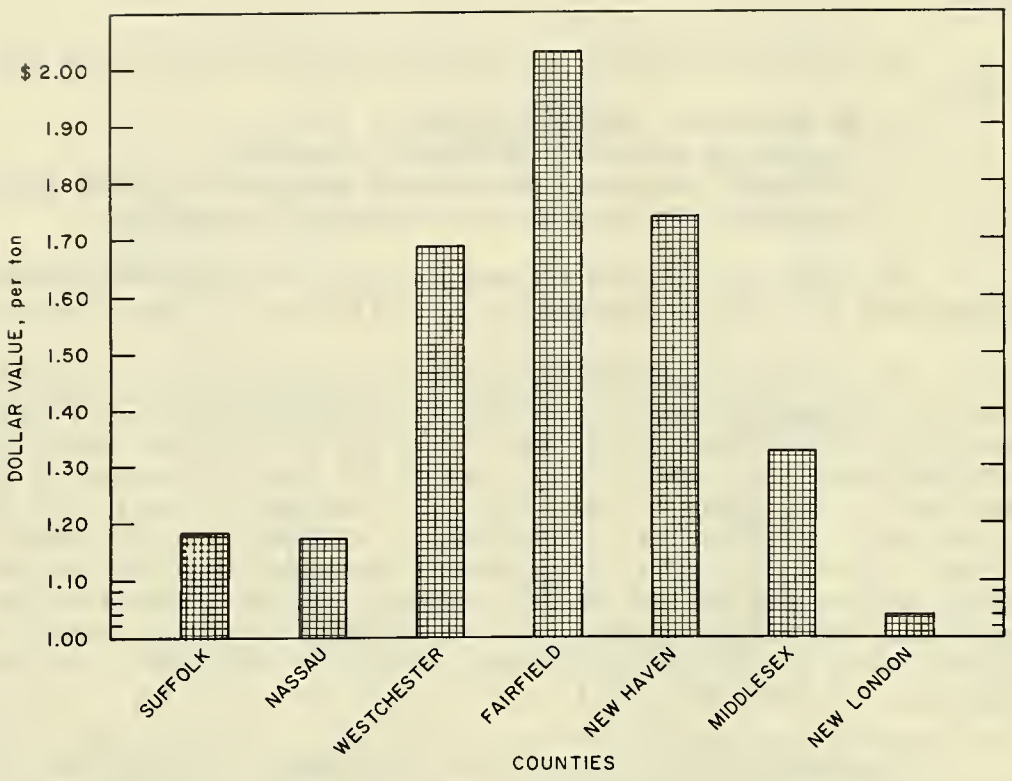

Figure 14. Average price, by county, for sand and gravel, f.o.b. plant, 1970.

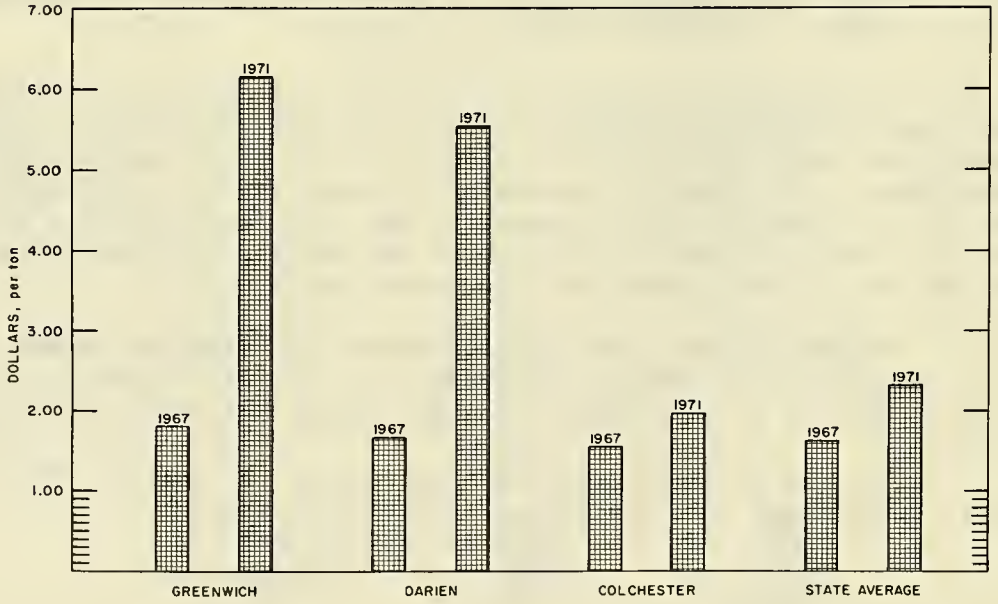

Figure 15. Low "bid" prices for washed sand delivered to selected Connecticut towns. Data Source: State of Connecticut, Contract Awards for Sand and Gravel, 1967 and 1971.

4.6 Future supply

Against a background of recent levels of production, table 3 recapitulates quantified information on readily available reserves of sand and gravel. More detailed information for the Connecticut portion of the study area is to be found in Appendices E and F. No estimate of available reserves of stone has been attempted; however, stone reserves appear to be ample for the foreseeable future.

TABLE 3. POTENTIAL RESOURCES AND AVAILABLE RESERVES
(in million short tons)

County	Sand and Gravel		
	Production Level		Estimated 1970 Potential Resources & Available Reserves
	1965	1970	
New London	0.3	0.5	660[b]
Middlesex	a	.4	40[b]
New Haven	1.6	1.2	100[b]
Fairfield	.7	.5	20[b]
Westchester	a	.1	0
Bronx	.0	.0	0
Queens	.0	.0	0
Nassau	4.2	4.5	120[c]
Suffolk	5.0	1.8	
Long Island Sound	-	-	d
Total	12.3	9.0	

a. Data withheld by U.S. Bureau of Mines to avoid disclosing individual company confidential data; included in "Total".

b. Resources for that portion of the counties located within LIS boundaries. See Appendix C for a listing by town.

c. Available reserves based upon 1962 estimate of 162 million tons (6), less production reported to Bureau of Mines from then to 1970.

d. The bed of the Sound contains very large deposits of sand totaling billions of tons and minor deposits of gravel. Availability of these resources is limited by potential environmental constraints that have not been quantified.

Table 3 brings out several points:

- There are still many uncertainties that should be resolved to provide an adequate basis for planning and management. This is evident from the number of blanks and footnotes required in the table.

- Notwithstanding these information gaps, it is clear that estimated available reserves are rapidly being depleted in Suffolk and Nassau counties. Even at the low 1970 rate of production, estimated available reserves will be fully depleted in 19 years.

- If the demand projections given earlier in table 1 prove to be correct, and the rate of production rises accordingly, the available Nassau-Suffolk reserves will be depleted in 14 years even if used solely to satisfy demands in those two counties. At a finer scale, local shortages will be experienced much sooner. Indeed they already exist.

5.0 PLANNING OBJECTIVE

The goal of the Long Island Sound Regional Study is to produce a plan of action by the Spring of 1975, which balances the needs to protect, conserve, and wisely develop the Sound and its related shorelands as a major economic and life-enriching resource for the 12 million people who live near the Sound.

This goal can be reached by reflecting society's preferences for attainment of two coequal study objectives, as established by the U.S. Water Resources Council (16):

1. Environmental Quality (EQ), which enhances the quality of the environment through the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

2. National Economic Development (NED), which increases the value of the Nation's output of goods and services and improves national economic efficiency.

For this report on Mineral Resources and Mining, the planning objective is:

- To develop and promote alternative courses of action which lead to a balanced plan to satisfy regional needs for mineral resources (mainly the mineral commodities used for construction

purposes --- sand and gravel, and stone). The plan should provide for the region's self-sufficiency in construction mineral commodities at the lowest cost with a minimal environmental impact.

To meet the planning objective, alternatives have been formulated and evaluated in terms of environmental, economic, and social criteria. Three plans were considered, one emphasizing EQ, one emphasizing NED, and one reflecting a composite of the two.

6.0 ALTERNATIVES

To meet the objective --- satisfy regional needs for mineral resources --- six alternative approaches have been considered, five could contribute to the work group's goal. The alternatives are:

- Sequential land use
- Mine the Sound
- Manufacture sand from stone
- Import from outside the region
- Modify specifications
- Do not meet needs

Substitution of other materials (such as marine muds) was not considered a viable alternative to meet needs in the quantity in which natural sand and gravel and stone are presently utilized in construction.

Reducing demand was not considered an alternative.

7.0 EVALUATION OF ALTERNATIVE MEASURES

Appendix G contains, in table form, a detailed evaluation of each alternative as measured by numerous environmental, economic, and social criteria. These criteria were developed by LIS management as an aid in evaluating each alternative with respect to guidelines prepared by the U.S. Water Resources Council. Judgments as shown in the evaluation matrix reflect the most likely, overall, long-term, and widespread impacts of implementing a specific alternative. Footnotes to Appendix G describe terms, and in some cases explain the basis for the evaluation.

In this section the highlights of the evaluations are presented; first the major environmental, economic, and social premises on which the evaluations were based, and then each alternative considered as a sole means of satisfying the objective. Table 4 is a summary of the evaluation matrix in Appendix G.

TABLE 4. EVALUATION SUMMARY OF ALTERNATIVE MEASURES

Alternatives in Minerals Planning	OVERALL EVALUATION		
	Environmental	Economic	Social
Sequential land use	Fair	Good	Fair
Mine the Sound	Fair to Poor	Fair	Fair
Manufacture sand from stone	Fair	Fair to Poor	Fair
Import from outside the region	Good	Poor to Fair	Good
Modify specifications	Fair	Poor to Fair	Fair
Do not meet needs	Poor	Poor	Poor

7.1 Major environmental considerations

Man affects the environment through his needs for construction materials. He cannot completely erase these effects, but he can attempt to minimize or ameliorate effects. Environmental evaluations have been tempered by the following premises:

1. Without sufficient supplies of construction mineral commodities, the present environment of the LIS region would deteriorate.

   Regional air and water quality, as well as the quality of the land, are controlled in part by structural measures. Construction, maintenance, and the eventual rebuilding of structures require a continuing supply of mineral commodities.

2. Mineral extraction, by its very nature, is a physical disturbance of the earth --- the environment.

3. Mineral extraction has a local impact, and is an interim use of the land --- it can be accomplished with minimal long-term effects on the environment.

As reflected in table 4 and in Appendix G, the evaluation of environmental criteria support any alternative which would meet needs. To a lesser extent, environmental criteria would favor imports over sequential land use, manufactured sand, and the modification of construction specifications. The least favored alternative would be mining the Sound, because of the lack of adequate knowledge of the environmental effects of mining within the Sound.

7.2 Major economic considerations

There are no significant substitutes for sand and gravel and stone in the quantity and quality presently used in construction. Economic evaluations have been based in part on the following premises:

1. Mineral resources are finite.

   Mineral resources are nonrenewable and occur at specific locations. Once mineral lands are preempted, they are generally lost to society forever. When mineral resources are utilized, they are lost unless they can be recycled.

2. Transportation charges are a major portion of the costs of these bulk items to the consumer.

   The nearer a commodity is to its point of use, the less it will cost the consumer.

3. Costs are distributed to all segments of society.

   The individual homeowner, industry, and government utilize the construction mineral commodities. Costs are distributed individually, locally, regionally, and nationally.

As reflected in table 4 and in Appendix G, the most economically favorable alternative to meet regional needs would be sequential land use. Mining the Sound might be equally attractive depending on regulatory practices formulated in the future.

7.3 Major social considerations

Projections of future needs for construction mineral commodities were based on population growth which in turn presumes construction activity. Limits on construction could reduce demand, thereby extending the life span of the resource base. It is doubtful limits on construction could be imposed. In any event, the life span of existing facilities is not infinite and materials must be available for reconstruction and repairs. Social evaluations were tempered by the following premises:

1. Health, safety, and the welfare of society are dependent on a continuing supply of construction mineral commodities.

   Houses, housing complexes, high-rise apartments, hospitals, churches, shopping centers, multistory office buildings, transportation systems, and flood control structures utilize construction mineral commodities.

2. A time of crisis may be approaching in the LIS region relative to the availability of mineral supplies.

Mineral resources will have to be utilized from areas designated by Nature. No longer can the mining of mineral commodities be forever delegated to another region.

3. To insure a continuing supply of construction mineral commodities, social and private land use conflicts will have to be reconciled.

Mining activity in populated areas often results in land use conflict. In order to meet needs of the region, it may be necessary for government to impose new land use controls.

As reflected in table 4 and in Appendix G, social criteria support any alternative which would meet needs. Of the individual alternatives, imports would be the most socially acceptable (if needs could be met) with sequential land use and mining the Sound less favorable.

7.4 The alternatives

Each alternative must be weighed independently with respect to the capability to satisfy needs. Not all alternatives are capable of meeting needs; a combination of measures may be necessary for a balanced plan.

Sequential land use. Many factors contribute to the decline in the availability of construction mineral commodities: conflicting land use, public opinion, environmental concern, and restrictive zoning. A logical alternative to meeting the needs of the region for construction mineral commodities would be to promote a change in present attitudes so as to permit greater use of local resources.

The public is concerned with heavy truck traffic, load spillage, noise, and dust surrounding mineral operations, as well as reduction of adjoining property values and loss of landscape quality. These problems can and are being solved. The general public's view of mineral resource development is that mineral commodities can always be mined in areas other than in which they live. This attitude is in conflict with the realities of deposit location, hauling cost, and market needs.

To date, most regional plans in the study region have not provided for mineral production, even though a continuing mineral supply is a necessary and critical part of the economy. Implementation of the proposed plans would require the use of mineral commodities; the plans do not concern themselves with the source of the mineral commodities.

Mineral production can be a compatible use within any comprehensive land-use plan. Mineral producers and planners could join forces for the protection of mineral reserves to satisfy future demand by promoting efficient urban development. The concept of open space could be developed with mineral production as an interim use. Recreation sites, such as skeet ranges, campsites, fishing ponds, golf courses, and auto racing tracks, could be developed on mined lands. Most commercial and residential buildings can be constructed on properly reclaimed lands.

An investigation of local regulations and jurisdictions controlling mineral operations within the study region reveals a maze of conflicts and inconsistencies. In many instances, mineral extraction is forbidden in areas geologically rich in mineral resources. These actions indicate the desirability of establishing uniform regulations governing mineral extraction and surface mine rehabilitation throughout the region.

To promote sequential land use, a regional or State mineral resources policy which would provide for the identification of areas with mineral potential should be considered. Extraction and reclamation could be directed towards a preestablished end use of the land to meet local needs.

Implementation of a mineral resource policy could provide for additional information on mineral resources. It could lead to studies of physical characteristics of quality and condition that determine economic feasibility and could include an economic analysis of needs with provisions for a periodic review.

Such a policy could establish mineral resources extraction as an interim land use and could encourage appropriate interim zoning. It could also regulate in a uniform manner (as will New York's Mined Land Reclamation Law) the operation of surface mines, the appearance of operations, rehabilitation of active operations, and provide for restoration of "orphan" lands.

Regulations should be equally stringent for all producers of a specific commodity so as to preclude giving any operator an economic advantage other than one attributable to the natural advantages of location, size, and quality of deposits. Regulations should be flexible enough to allow for differences in individual deposits, methods of mining, and the commodities being mined. The differences between stone quarries and sand and gravel pits should be considered in any regulations.

Appendix H provides an outline of general provisions for mining legislation which includes site plan, rehabilitation, and performance requirements.

A proposal for a State or regional minerals policy is not a new idea with respect to Long Island's sand and gravel. The report, "Long Island Sand and Gravel Mining" prepared by the New York State Office of Planning Coordination contains many recommendations of merit. It recognizes a need "for a subtle blend of advisory and regulatory powers stringent enough to

prevent damage to the environment but flexible enough to allow the economical utilization of a valuable resource." The State Report points out the regional significance of Long Island sand and gravel resources, the doubt as to whether municipalities would acknowledge regional needs, and suggests that trained personnel and the complex equipment needed for the proper monitoring of sand and gravel operations might be more available at the State or county level.

It is noteworthy that many of the implementation proposals of the "Long Island Sand and Gravel Mining" report have been reflected in the New York State Mined Land Reclamation Law. Specifically, the report proposed --- "To protect Long Island sand and gravel, legislation is recommended to give the State, possibly through the Department of Environmental Conservation, key protective powers over lands with valuable sand and gravel deposits. This legislation should provide for preservation standards, mining permit policies, and operator licensing. It should also empower the State to develop procedures and regulations for overseeing mining operations, to prepare plans for reclaiming and rehabilitating abandoned sites, and to establish licensing procedures to regulate producers. All producers of sand and gravel would report to the State each year on their production and the State would also have the authority and personnel to inspect sand and gravel operations."

New York's law recognizes that no single State department or agency has broad enough purview to deal with all aspects of the complex problem. Though one department is responsible for mined land reclamation, provision has been made for coordination between the various State agencies involved in mineral policy.

Alternative means by which other states or regional jurisdictions could provide for mineral needs through a sequential land use policy are as follow:

1. Purchase of selected mineral-bearing lands for recreation or open space needs with provisions for the interim use for mining. Mining could be allowed through a lease system to industry, with provisions for rehabilitation of the site for end use within the State or regional master plan.

2. A tax incentive plan which would allow industry to acquire long-term reserves. Reserve areas would still have to be protected from encroaching suburban sprawl by enactment of some type of interim zoning.

3. A tax incentive to landowners whose lands contain mineral resources which could be mined and reclaimed prior to being committed to a final end use.

4. In parts of the Long Island Sound region, sequential land use would depend on the retention of existing rail and storage facilities to move mineral commodities.

Mine the Sound. The Long Island Sound Study area is a part of the most populous urban region in the United States, also the largest and most complex mineral aggregate market in the country. This region is concurrently subject to intense land use and construction pressures. A more complete discussion of marine mining in the Sound is to be found in "A Report on the Legal and Other Critical Issues Associated with the Offshore Extraction of Sand and Gravel in Long Island Sound" (1). It is sufficient to say here that several critical issues must be fully considered before a program is developed to extract submarine sand and gravel deposits from Long Island Sound. The first issue is geological: What are the sites, quantity, and quality of sand and gravel deposits in the Sound? A second issue is technological: Does technology exist for efficient extraction? A third issue is environmental: What immediate or long term damages are likely to result from an extraction-shipping-processing program? A fourth issue is socioeconomic: What is the economic feasibility of private market operation; and what is the magnitude of social costs and benefits expected? The final issue is legal and institutional: Who has jurisdiction on marine deposits, and what regulatory mechanisms are needed?

If an extraction program is to be developed, then a number of legal, regulatory, and institutional issues must be confronted and resolved before any specific projects can be carried out.

Marine geology. -- A comprehensive study of the geology of the bottom of Long Island Sound was done in 1970 by Grim et al, as described in the report by Baram and Lee (1). Grim described four subbottom layers which were identified by seismic reflection profiles. Two layers --- the top layer described as recent sediments, and the next layer described as glacial deposits --- are important with respect to sand and gravel extraction.

On the basis of more than 200 shallow core samples and bottom samples, McCrone (1961, 1966), as stated in the report by Baram and Lee (1), described the upper 6 feet as a sandy to clayey, Holocene silt, covered in most places by several inches of black gelatinous, organic mud. However, some borings and cores taken by the Corps of Engineers indicate thickness of several feet of organic silt. In areas where the second layer is not covered by this silt, the bottom surface is composed of outwash deposits. On the basis of seismic reflection profiles, Grim concluded that this first layer may be up to 40 feet in depth but may be less than 12 feet (limit of detection). The next layer is several hundred feet thick.

The U.S. Army Corps of Engineers, which is interested in offshore sand deposits for beach restoration and stabilization, has undertaken the "Sand Inventory Program." Seismic reflection profiles, as well as vibracore samples of the bottom were used as exploration tools, on a reconnaissance basis. More detailed investigations were conducted for a small area off Bridgeport. There is significant interest in Long Island Sound as a source for sand and gravel and indications are that deposits do exist for economical extraction. It should also be apparent that the data are insufficient to predict reliably the total amount of submarine sand and gravel in the Sound.

Technology. -- Dredges are used to recover solid materials underwater. While some type of mechanical dredge, such as the dipper or the bucket, can be used for underwater mining, it is likely that some kind of hydraulic dredge will be the most satisfactory. For beach replenishment purposes, the pipeline dredge, usually in combination with a hopper dredge, will probably be used. To obtain marine sand and gravel for use as construction aggregate, the suction hopper dredge (a self-contained hydraulic dredge) will probably be preferred. Recent developments have greatly increased the versatility of these suction hopper dredges. Heretofore, the dredging of materials using suction hopper dredges has been limited to relatively shallow waters of about 100 feet. The Coastal Engineering Research Center (CERC) limits their search for marine sand deposits to those within waters of 100 feet for this reason. However, recent dredge design has overcome this obstacle. New technology has been proven, is available for use in Long Island Sound, and increases the potential for an offshore extraction program.

Environmental. -- A mineral extraction program would require further study to determine the environmental effects.

Environmental benefits can be expected to follow from an offshore extraction program. Beach nourishment and erosion control projects using offshore sand and gravel are beneficial to the environment and recreational potential of the area. The mining of offshore deposits can be expected to relieve pressures for landward extraction and thereby reduce landscape destruction and the multiple "nuisances" associated with pits and quarries.

Three main types of potentially adverse environmental impacts are associated with offshore mining. The first is the alteration of the bathymetry since the removal of aggregate causes a change in the bottom profile.

The second is the impact on biota. Dredging and dredger overflow can produce considerable amounts of sediment suspension, causing turbidity in the water column which may block light required for photosynthesis. The disturbance of the bottom sediments also releases nutrients and possibly heavy metals. Sediments also impact directly on such bottom dwellers as crustaceans and mollusks. The effect on fin fish may, however, be minimal since they can effectively avoid the sediment plume except perhaps during crucial life cycle periods.

The third is the impact upon the receiving sites and adjacent land. If offshore sand and gravel mining for commercial purposes is allowed, there will be associated truck traffic to and from the receiving areas. The receiving areas may be considered objectionable because of general "nuisance" effects.

In sum, there appear to be some inevitable and possible irreversible adverse impacts on the environment when offshore mining is undertaken. Decisionmakers and their constituents must decide whether the benefits adequately offset these damages. It is only when studies are implemented and tradeoffs are enunciated and approved, that rational programs and projects can be devised.

Economics. -- Economic feasibility will depend on several factors, primarily the amount of sand and gravel in the Sound. As indicated earlier, there are reasonable assurances that substantial sand deposits exist, but the available information is insufficient to delineate in detail the full extent of the deposits. The limited data make it impossible to use conventional methodology to estimate the amount of sand and gravel. At best, estimates will carry large degrees of uncertainty. Further geological information should indicate the amount, type, and location of deposits. If it were determined that sufficient suitable material does exist, then, economically, marine mining could be competitive with mineral extraction from land sources. Socially, marine mining in the Sound may be more acceptable than land mining. Conflicts between landowners and mineral operators would be less likely to arise.

Legal and institutional. -- Should the above questions be satisfactorily resolved for offshore mining, proponents would still be confronted with significant legal and institutional questions. The first issue is who has jurisdiction over the resource? Long Island Sound lies entirely within the Federal-established boundaries of New York and Connecticut. Except in rare cases, the States own the mineral resource of the submerged lands of the Sound which they hold in trust for the people of New York and Connecticut. New York also continues to recognize the rights of private parties to certain submerged lands granted by colonial patents which predated 1776. If mining were to take place on such private lands, it would still be subject to regulations.

The Federal Government maintains extensive jurisdiction over activities in navigable waters. The U.S. Army Corps of Engineers has been provided with the preeminent authority to protect navigability and manage harbor and channel improvements. The Corps exercises this authority through its permit programs for dredging and related activities, in well-established and formal procedures.

In both New York and Connecticut, mining for aggregate must have the approval of several State agencies. It should be noted that New York law specifically prohibits the taking of sand and gravel from submerged lands in, on, or bordering upon Long Island Sound except in association with Corps of Engineers-approved channel dredging.

If mining is to take place in wetlands areas, then it is also regulated by the wetlands protection laws of New York and Connecticut. Also, offshore mining projects could be in conflict with recreation, commercial navigation, and in nearshore areas, with shellfish cultivation.

Finally, there are a number of other requirements which would have to be met by any offshore mining project, such as State and Federal environmental impact assessments and compliance with both New York and Connecticut water quality regulations.

Manufacture sand. Another alternative by which the region could possibly meet its needs for construction aggregate would be to substitute crushed stone for natural sand and gravel. Crushed stone is increasingly satisfying the demand for coarse aggregate as natural gravels are becoming depleted or unavailable. Stone sand is a marketable and competitive product in some areas where natural sands are not available. The problems facing stone producers are the same as those confronting producers of sand and gravel. The same issues --- conflicting land use, public opinion, environmental concern, and restrictive zoning --- preclude any guarantee as to the availability of stone resources for future needs.

Stone operations have a longer life span than most sand and gravel operations and present reserves appear to be ample for the foreseeable future. In order for crushed stone production to meet the anticipated needs of the region for all aggregate material, production would, at the very least, have to triple. It is not known whether reserves now available to industry could fulfill this demand. Mineral lands would have to be made available for new quarry operations to meet this greatly increased demand.

Several factors must be considered in evaluating the suggestion that stone become the prime source of construction aggregate material within the LIS region. Long Island, Bronx, Queens, and Westchester do not have available stone reserves --- all construction aggregate material would have to be imported with undoubtedly increased cost to the consumer. The availability of stone from other areas such as Connecticut and other parts of New York will have to be considered.

To insure the availability of stone to meet future needs, a State or regional minerals policy could be adopted, similar to that described under the sequential land use alternative. An analysis should be made of current construction specifications to determine whether stone could satisfy all needs before formalizing a plan dependent solely on stone.

Evaluation of environmental criteria do not favor the expansion of stone operations to meet all demand for aggregate. Typical stone operations have a longer life span, reclamation is more difficult and costly, and land is more limited in final end use than in the case of sand and gravel operations. Underground operations would be more compatible in the environmental sense, but any increased costs would have to be passed along to the consumer.

The manufacture of sand from stone would consume more energy and be less economical than the utilization of sand from other sources. With the current energy shortage, adequate energy may not be available in some locations to manufacture large quantities of stone sand. An additional problem has arisen as the disposal of extreme fines created during conventional crushing operations has become increasingly difficult. Research is needed to develop methods of utilizing fines created by the manufacture of sand.

Imports from outside the region. A possible alternative to meet the needs of the LIS region is to import mineral commodities from outside the region. In another section of this report, it has been stated that an exchange of mineral commodities between the subregions already exists. Stone from Connecticut is shipped to New York ports and Long Island sand and gravel to New York City. Imports and exports of commodities beyond the LIS regional boundary are difficult to quantify.

Reliance on imports could have positive as well as negative attributes. In a positive sense, residents of the region would no longer be concerned with active extractive operations. There would be no more disturbances to the land by mining. Yet, land would be needed for stockpiling materials at distribution terminals.

An important negative aspect to consider is --- Will imported materials continue to be available to meet needs? There would be no guarantee that other areas would continue or begin to supply materials to the study region. Land use and social pressures could terminate the availability of materials in these areas in the same manner as in the study region. Do other areas have resources to export? How many tons? Will there be enough to satisfy needs? Answers to these questions will have to be considered before planning a future based on imports.

Costs to the consumer would increase considerably, mainly because of the increased distances the commodities would have to be shipped as well as the increase in the handling of the materials.

Modify specifications. This alternative cannot satisfy needs by itself. Most construction is governed by specifications which require a certain quality (physical and chemical) in aggregate material. Modified specification requirements for a processed mineral product could expand the supply of available material. The Bureau of Materials in the New York Department of Transportation has instigated this action with positive results. Some construction specifications are unnecessarily rigid. A simple modification of the gradation requirement for portland cement concrete sand has increased the reserves of concrete sand in New York State. Some specifications cannot be changed, since they reflect minimum health and safety requirements.

A reduction in specification requirements could be economically beneficial. Mineral products could conceivably require less processing, with a savings in consumer cost. Deposits near a point of mineral consumption could possibly be utilized more fully, with significant savings in transportation costs. However, modifying specifications could cause an increase in use of other commodities such as cement, lumber, and steel.

Under this alternative, it would be necessary to undertake the following:

1. Investigate the feasibility of modifying construction specification standards.

2. Conserve higher grade materials for specific uses, especially those in deposits nearest points of consumption.

3. Promote the recycling of materials.

Do not meet the needs. To not meet the needs of the region for construction mineral commodities would result in economic, social, and environmental deterioration. The quality of life as we know it would suffer --- no new individual housing, high-rise apartments, multistory office buildings, or shopping centers --- no new churches or schools --- no new highways or mass transit systems or regional sewage treatment facilities. Also, existing facilities which have a limited life span would deteriorate. This alternative should not be considered as a plan for the LIS region.

8.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

Three alternative plans were considered for the region --- one emphasizing the environmental quality objective (EQ), one emphasizing the national economic development objective (NED), and a composite plan. The plans were developed from alternatives outlined in section 6.0, the evaluation provided by the entries in Appendix G, and the description of alternatives in section 7.4. The composite plan was developed in further detail.

8.1 Environmental Quality Plan

Narrowly construed, a minerals plan emphasizing environmental quality for the region would rely mainly on modifying specifications and increasing imports from outside the region to satisfy demand. However, imports alone cannot satisfy total demand, nor could modifying specifications contribute substantially to meeting demand. Appendix G points out the environmental hazards of not meeting demand. In a broader sense, realizing mineral needs have to be met, an environmental quality plan should stress environmental safeguards during extractive and processing operations and maximize reclamation of mined areas.

8.2 National Economic Efficiency Plan

Narrowly construed, a minerals plan emphasizing national economic development would stress the utilization of mineral commodities nearest their point of consumption, as transportation charges greatly increase the price of the product. This would entail both land mining and marine dredging, depending on the proximity of the commodity being mined to its market. The NED plan would not require restoration of sites nor environmental safeguards during mining and processing operations, as these contribute substantially to the price of the product.

8.3 Composite Plan

A composite plan has been developed by the work group to meet demand for mineral commodities. The composite plan is primarily a combination of an EQ plan and a NED plan. The plan emphasizes sequential land use with restoration of mine sites, mining in the Sound, and importation of commodities from areas along the peripheral edges of the region.

The composite plan would entail the following activities:

- Sequential use of mineral lands.
- Provision for the restoration of abandoned properties.
- Determination of availability of material on Long Island.
- Study of the feasibility of mining the Sound.
- Mining of the Sound.
- Continued importation to satisfy some needs.
- Modification of specifications.
- Manufacture of sand.
- Preservation of rail transportation facilities.

8.4 Analysis of the Composite Plan

Present practice. A comparison of trends in the price of sand and gravel (f.o.b. plant) from 1967 through 1972 indicates monetary benefits the LIS region could receive by enactment of an effective sequential land use plan. Table 5 compares the real cost of sand and gravel in the LIS region with surrounding States in the 1967 through 1972 base period, while figure 16 depicts f.o.b. plant prices in 1967 constant dollars projected to benchmark years.

TABLE 5. PRICE PER TON OF SAND AND GRAVEL, F.O.B. PLANT (1967 constant dollars)[a]

Area	1967	1972	Percent annual increase
Connecticut	1.05	1.44	5.7
Rhode Island	1.03	1.30	5.2
New York	1.02	1.12	2.0
LIS area	1.06	1.04	--- (decrease)

a. Based on 1972 price index (123.3) for construction sand and gravel, Bureau of Labor Statistics, U.S. Department of Labor. Weighted average f.o.b. plant price.

Near optimum producing conditions occurring on Long Island during the 1967 through 1972 base period have greatly influenced the weighted average f.o.b. plant price for sand and gravel in the LIS region. The large deposits of sand and gravel, the great quantity produced, the competitive climate, and increased efficiency and productivity in extractive operations on Long Island have contributed to an overall decrease in f.o.b. plant price expressed in 1967 constant dollars. During the same base period, three of the four Connecticut counties in the LIS region have experienced annual increases in f.o.b. plant price ranging between 1.8 to 3.7 percent. The rates of increase for the Connecticut counties have little effect when a weighted average price is calculated for the LIS area as a whole.

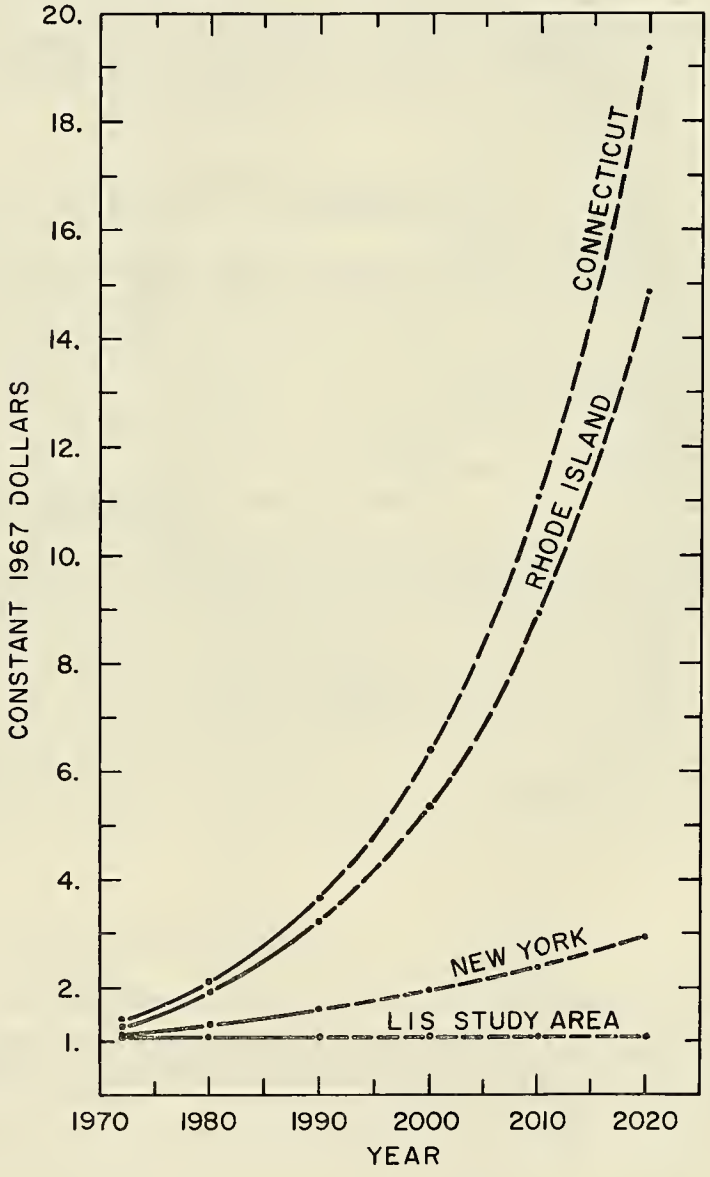

Figure 16. Projected f.o.b. plant price per ton for sand and gravel.

The annual rate of price increase for New York is influenced by the significant quantities (table 1) of sand and gravel produced on Long Island. If production from the New York counties in the LIS region (Nassau, Suffolk, and Westchester) is excluded, the annual rate of price increase (f.o.b. plant) for the remaining portion of the State would increase by nearly 1 percent.

Sequential land use. For purposes of comparison, it is assumed that the low rate of increase shown for the region in table 5 and the prices presented in figure 16 (caused mainly by abundant supplies of sand and gravel on Long Island in the past) would remain much the same if a sequential land use plan were in force. A sequential land use plan would provide for continued availability of resource lands for mineral extraction. However, if a sequential land use plan is not enacted and the recent trend toward restrictive zoning is continued on Long Island, the price curves for the LIS study area and New York will be similar to those projected for Connecticut and Rhode Island.

Producers in other areas have reported a 25- to 30-percent reduction in f.o.b. plant prices (the former prices comparable to present practice prices in Connecticut) while operating under a sequential land use plan. Undoubtedly, sequential land use in the region would result in increased resource availability and lower f.o.b. plant prices.

Many areas within the region have zoned out mineral production and are importing to meet their needs. Earlier sections of this report have stressed the increasing unavailability of resource lands for mineral production. Without a viable and complete sequential land use plan, the study region can look forward to increasing f.o.b. plant prices for sand and gravel on the same magnitude as projected for Connecticut and Rhode Island (fig. 16). Savings to the region under a sequential land use plan would be substantial, and enactment of such a plan is the most logical course for the region to follow.

Marine mining. The work group is proposing a study to determine the feasibility of mining within the Sound. If the economic, environmental, legal, and jurisdictional problems can be overcome, mineral extraction within the Sound is recommended. Land resources of sand and gravel are finite, and in the future, the region will probably have to turn to the Sound to supplement its needs.

Information from private industry shows that the cost of producing a ton of sand and gravel by marine mining methods would run about 10 percent less than present mining methods used in Connecticut, but 15 to 20 percent more than the proposed sequential land use method.

Imports. Imports will have to be continued to satisfy some needs, mainly the import of stone to Long Island and sand, gravel, and stone to heavily urbanized Bronx, Queens, and Westchester.

Charges for transporting mineral commodities (discussed in Section 4.4) over short distances, quickly double f.o.b. plant prices for sand and gravel. Increasing transportation charges added to the increasing f.o.b. plant prices caused by current practices, will soon make the cost of many construction projects prohibitive.

Comparison of mining plans. Total f.o.b. plant value for different mining plans can be calculated from the data presented in the preceding paragraphs, prices depicted in figure 16, and the calculated demand for the LIS region contained in Appendix E. Table 6 shows projected plant value of sand and gravel under three mining plans in benchmark years. Marine mining values do not include costs of transporting to shore and unloading.

TABLE 6. PROJECTED F.O.B. PLANT VALUE OF SAND AND GRAVEL FOR THE LIS STUDY AREA IN BENCHMARK YEARS[a]
(1967 dollars)

Year	Present practice (Connecticut)	Mining Plan	
		Marine Mining	Sequential land use
	(million dollars)		
1980	22	20	16
2000	110	99	79
2020	384	346	279

a. Calculated from annual demand computed by methodology presented in Appendix E. Includes the entire area of Nassau, Suffolk, Bronx, and Queens.

As shown in table 6, sequential land use is the mining plan most likely to decrease f.o.b. plant prices in the LIS region. If sequential land use is allowed near current demand centers, consumer costs would be lowered.

Benefit-cost analysis of the recommended minerals program has not been attempted for this study. It would become a major project to quantify total social costs versus total accrued benefits for any specific alternative, much less a combination of alternatives. External costs are very difficult to quantify and available data does not allow dollar values to be realistically distributed in this manner. A rating of alternatives has been attempted in general terms in Appendix G.

9.0 WORK GROUP RECOMMENDATIONS

Implementation of the composite plan as detailed in the foregoing section would require the following actions:

Use land sequentially. To meet the major portion of the region's mineral needs --- establish a regional minerals policy with uniform regulations for sequential land use, which insures the availability of minerals and incorporates environmental safeguards.

Determine availability of Long Island sand supply. To reduce existing uncertainties regarding mineral supplies --- assess the availability of sand on Long Island.

Study offshore deposits. To provide essential information --- conduct a multiagency study to determine the quality, quantity, and location of sand and gravel deposits within Long Island Sound. The study should include the environmental, legal, technical, and economic feasibility of mining to meet regional needs.

Mine offshore. To help meet future mineral needs --- States make provisions for mining in the Sound.

Import minerals. To help meet future needs for minerals --- States promote a continuation of imports from peripheral areas.

Modify specifications. To conserve higher grade materials for specific uses, especially those in deposits nearest consumption --- investigate the feasibility of modifying construction specification standards --- promote the recycling of materials.

Preserve rail transportation links. To retain a capability for distribution of mineral commodities --- States encourage the preservation of existing rail and storage facilities.

Restore abandoned sites. To improve the appearance of the land --- States assist and encourage communities (through a combination of legal means, land use incentives, funding, and community development programs) to restore or remove abandoned excavations, equipment, piers, structures, and scows.

Use fines. To alleviate waste disposal problems --- develop through research, methods of utilizing fines generated by crushing operations.

10.0 FINAL RECOMMENDATIONS

The preceding recommendations have not necessarily been approved by the New England River Basins Commission. At the time of this report's publication, the draft main report of the Long Island Sound Regional Study is undergoing public review and comment for consideration in the final document. The FINAL RECOMMENDATIONS on Mineral Resources and Mining are therefore to be found only in the final version of the Study's main report--to be published in the Spring of 1975.

APPENDIX A

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APPENDIX B

GLOSSARY

Aggregate - Uncrushed or crushed gravel, crushed stone or rock, sand or artificially produced inorganic materials.

Alluvium - Clay, silt, sand, gravel, or other rock materials transported by flowing water and deposited in comparatively recent geologic time as sorted or semisorted sediments in riverbeds, estuaries, and flood plains.

Esker - A long narrow ridge of sand and gravel, once the bed of a stream flowing beneath or in the ice of a glacier; deposited when the ice melted.

Glaciofluvial - Of, pertaining to, produced by, or resulting from combined glacier action and river action.

Igneous Rocks - Rocks or minerals solidified from molten or partly molten material.

"In Bank" - Naturally occurring aggregate mined and used without processing.

Intrusive Rocks - Rocks in a molten state emplaced in preexisting rocks.

Lacustrine - Pertaining to, produced by, or formed in a lake or lakes.

Metamorphic Rocks - Any rocks altered by heat or intense pressure, causing new minerals to be formed and new structures in the rocks; such as clays being changed to slates.

Sequential Land Use - In regard to minerals, provide and allow mineral extraction before land is committed to an end use incompatible with mining.

Terminal Moraine - A ridgelike accumulation of drift built along the margin of a valley glacier or ice sheet.

Unit Train - An entire railroad train used solely to transport one commodity.

APPENDIX C

POTENTIAL SAND AND GRAVEL RESOURCES
FOR CONNECTICUT TOWNS IN LIS AREA

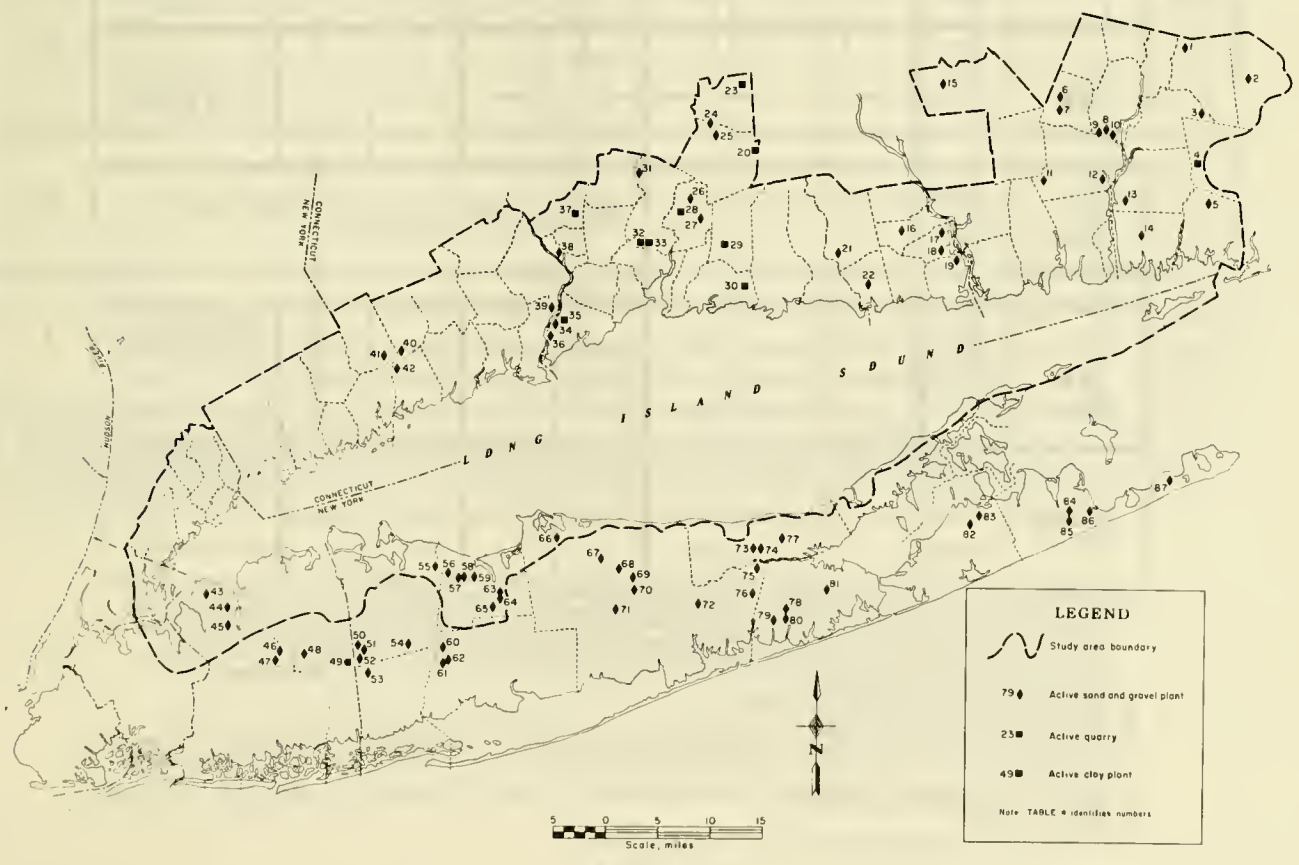
Town	Quantity (tons)	Town	Quantity (tons)
Ansonia	0	Montville	26,726,500
Bethany	12,075,000	New Canaan	315,000
Bozrah	18,112,500	New Haven	0
Branford	630,000	New London	0
Bridgeport	0	North Branford	8,872,500
Chester	8,347,500	North Haven	7,122,500
Clinton	3,027,500	North Stonington	76,077,200
Colchester	68,215,000	Norwalk	0
Darien	0	Norwich	10,465,000
Deep River	4,232,500	Old Lyme	17,360,000
Derby	0	Old Saybrook	3,898,800
East Haven	0	Orange	4,445,000
East Lyme	15,139,500	Preston	29,856,000
Easton	4,392,500	Salem	20,752,500
Essex	4,051,300	Seymour	7,035,500
Fairfield	1,225,000	Shelton	1,750,000
Franklin	50,177,500	Sprague	28,825,000
Greenwich	0	Stamford	350,000
Griswold	122,010,000	Stonington	20,114,800
Groton	10,502,500	Stratford	0
Guilford	7,962,500	Trumbull	1,452,500
Hamden	14,910,000	Voluntown	36,732,500
Killingsworth	11,042,500	Wallingford	12,661,500
Ledyard	36,399,500	Waterford	5,985,000
Lisbon	16,945,000	Westbrook	5,015,000
Lyme	60,176,500	West Haven	0
Madison	10,202,500	Weston	945,000
Meridan	1,596,000	Westport	2,047,500
Milford	3,587,500	Wilton	385,000
Monroe	7,590,000	Woodbridge	4,585,000

Data Source: Connecticut Department of Transportation, Bureau of Highways, Soils and Foundations Division. Construction Aggregate Availability Study. Summary Reports: 1966, 1970, 1972.

APPENDIX D

MINERAL PRODUCERS IN THE LIS AREA (1970)

1. American Sand and Gravel
2. Bronson Construction Company
3. B & O Sand and Gravel Company
4. Ottowa Silica Company
5. Rudy Cirioni
6. Seymour Adelman Sand and Stone, Inc.
7. The Ryan Company
8. Operator Unknown
9. Operator Unknown
10. The Ryan Company
11. L. H. Bond Sand and Gravel, Inc.
12. John J. Doyle Sand & Gravel Co., Inc.
13. James Romanella & Sons, Inc.
14. New London Sand & Gravel Company
15. S & Z Construction Company
16. Shoreland Sand & Gravel Company, Div. of Blakeslee
17. Operator Unknown
18. Operator Unknown
19. Operator Unknown
20. New Haven Trap Rock Company, Inc.
21. Shore Line Washed Sand and Stone Company, Inc.
22. Shore Line Concrete
23. York Hill Trap Rock Quarry Co., Inc.
24. City of Meriden
25. Meriden Wallingford Sand and Stone Company, Inc.
26. Estate of Stillman H. Rice
27. Operator Unknown
28. Plasticrete Corporation
29. New Haven Trap Rock Company, Inc.
30. Castelucci and Sons, Inc.
31. Operator Unknown
32. C. W. Blakeslee and Sons, Inc.
33. A. N. Farnham, Inc.
34. Beard Sand and Gravel Company, Inc.
35. J. F. Barrett and Sons Company, Inc.
36. D. J. Carten
37. Operator Unknown
38. Derby Sand and Asphalt
    Beard Sand and Gravel Company
39. Galluci Properties - Waterbury Sand and Gravel Company
40. Operator Unknown
41. Jayne Brothers
42. Operator Unknown
43. Colonial Sand and Stone Company, Inc.
44. Colonial Sand and Stone Company, Inc.
45. Penn Industries, Inc., McCormack Sand Division
46. Approved Sand and Gravel Company
47. Astro Sand and Gravel - Elm Concrete
48. Certified Industries
49. Nassau Brick Company, Inc.
50. West Hills Silica Sand Mining Corp.
51. Consolidated Sand and Gravel
52. Poscillico Brothers Asphalt Company
53. Operator Unknown
54. Clearview Concrete Pipe Company
55. Amfar Asphalt Company
56. Huntington Ready-Mix Concrete
    Kings Concrete, Sand, and Gravel
    Mike Nasti Sand Company, Inc.
57. Modern Concrete
    Park Ready-Mix
    Rite Contracting Corporation
    Suffolk Ready-Mix, Inc.
58. Indian Head Sand and Gravel
59. Star Sand and Gravel Corporation
    Park Sand and Gravel, Inc.
60. Certified Industries
61. North Construction Materials
62. Triple A Sand and Gravel
63. Colonial Sand and Stone Co., Inc.
64. Colonial Sand and Stone Co., Inc.
65. Acme Construction Supply Company
66. Suffolk Materials Mining Corp.
67. Brookhaven Aggregates Limited
68. Roanoke Marbro Sand and Gravel Corp.
69. Sal Picone and Sons, Inc.
70. Kogel Concrete
71. Lizza Corporation
72. Tully and Dinapoli Asphalt Corp.
    Grenwolde Mining Corporation
    Columbia Asphalt Company
73. Suffolk Cement Products, Inc.
74. Suffolk Cement Products, Inc.
75. Midhampton Asphalt Corporation
76. Oavis Construction Corporation
77. Riverhead Cement Block Co., Inc.
78. Operator Unknown
79. H. L. Bishop, Inc.
80. Operator Unknown
81. East Coast Mines, Ltd.
82. Bridgehaven Sand and Gravel, Inc.
83. Operator Unknown
84. Dragotta Construction Company
85. Bistrain Gravel Corporation
86. Mike DiSunnio
87. Operator Unknown



APPENDIX E

DEMAND, CAPABILITY, AND NEEDS BY SUBREGION

SUBREGION	COMMODITY	DEMAND[1]			CAPABILITY		NEEDS[2]		LAND REQUIREMENTS[5]	
		1970	1970-1990	1970-2020	Total Resource[3]	Available Resource[4]	1970-1990	1970-2020	1970-1990	1970-2020
		(million tons)	Cumulative Total (million tons)		(million tons)		Cumulative Total (million tons)		Cumulative Total Acres	
1*	Sand & Gravel	0.5	10.8	30.6	593.0	396.9	0	0	0	170
	Stone	0.2	3.9	11.2	Total resources are extensive; availability has not been determined. Resources are granitic-type rocks, not traprock. Existing quarry locations and facilities outside the Subregion satisfy demand.					
2	Sand & Gravel	0.1	2.8	8.9	117.2	81.7	0	0	0	50
	Stone	0.05	1.0	3.3	Total resources are extensive; availability has not been determined. Resources are granitic-type rocks, not traprock. Existing quarry locations and facilities outside the Subregion satisfy demand.					
3	Sand & Gravel	1.1	24.5	68.2	88.6	54.5	0	13.7	430	1320
	Stone	0.4	9.0	25.0	Total resources are extensive; availability has not been determined. Resources are granitic-type rocks and traprock. This Subregion exports a great quantity of traprock to other parts of LIS.					
4	Sand & Gravel	0.8	18.8	53.0	23.4	17.6	1.2	35.4	370	1140
	Stone	0.3	6.9	19.4	Availability has not been determined; resources are traprock and granitic-type rocks. Existing quarry locations and facilities outside the Subregion satisfy demand.					
5	Sand & Gravel	0.7	16	44.6	4.0	2.0	14	42.6	310	904
	Stone	0.3	5.9	16.3	Total resources are extensive; availability has not been determined. Resources are granitic-type rocks, not traprock. Existing quarry locations and facilities outside the Subregion satisfy demand.					
6a (Westchester)	Sand & Gravel	0.8	16.7	41.4	Unknown	0	16.7	41.4	Subregion demand is satisfied solely through imports.	
	Stone	0.3	6.1	15.1	Unknown	0	6.1	15.1		
6b (Bronx and Queens)	Sand & Gravel and Stone	4.4	97.1	150.9[6]	Demand in these counties is satisfied solely through imports from Connecticut, New York, and New Jersey.					
6c (Nassau)	Sand & Gravel	3.1	67.6	180.1	Extensive	15-30[4]	38-53	151-166	Acreage requirements cannot be determined until resource areas are mapped.	
	Stone	1.1	24.7	65.9	0	0	24.7	65.9	Stone is imported.	
7-8-9 (Suffolk)	Sand & Gravel	2.4	71.4	252.8	Extensive	91-106[4]	0	147-162	Acreage requirements cannot be determined until resource areas are mapped.	
	Stone	0.9	26.1	92.5	0	0	26.1	92.5	Stone is imported.	

1/ For Subregions 1, 2, 3, 4, 5, and 6a, demand for sand and gravel is based on a 7-year average of apparent per capita consumption, (2.16 tons), and town population projections. Demand for stone is based on a 3-year average of apparent per capita consumption, (.79 tons), and town population projections. Demand in Subregions 6c, 7, 8, and 9 is for total counties using the same methodology. Demand for sand, gravel, and stone in Subregion 6b (total counties) is based on a 4-year average of per capita consumption (1.28) determined from imports of sand, gravel, and stone reported by the Corps of Engineers in "Waterborne Commerce in the United States." Does not include imports by truck or rail. Ad Hoc Population Projections for Bronx and Queens were provided by BEA for the years 1970-2000.

2/ Difference between available resources and demand.

3/ Determined from Connecticut DOT maps.

4/ Interpreted from land use maps--includes sand and gravel deposits on lands mapped as extractive industrial and open (unused) uplands in Connecticut. A rough estimate of available sand and gravel resources on Long Island has been reported to be 121 million tons. This figure has not been verified. Tonnage was distributed in proportion to the number of producers in Nassau and Suffolk Counties.

5/ Resource acreage requirements in addition to those already classified as in extractive industrial use. Acreage based on an average deposit size in the Connecticut subregions.

6/ To the year 2000.

* Asterisk denotes subregion with potential for exporting sand and gravel.

APPENDIX F

RESOURCE AVAILABILITY BY LAND USE CATEGORY[1/]
(SUBREGIONS IN CONNECTICUT)

SUBREGION		AVERAGE[2/] DEPOSIT SIZE	AVAILABLE		POSSIBLY AVAILABLE				NOT AVAILABLE[3/]
			Extractive Industrial	Open (unused) Uplands	Agricultural	Forest[4/]	Industrial[5/]	Wetlands	Other
1	Tons	1,110,000	20,114,000	376,762,500	86,177,000	1,025,000	937,500	19,457,500	88,462,000
	Acres[2/]	18	358	6053	1415	20	18	342	1638
2	Tons	681,000	5,924,500	75,727,100	16,645,000	600,000	0	6,034,500	11,800,000
	Acres[2/]	12	114	1347	284	14	0	127	216
3	Tons	895,000	3,275,000	51,239,500	26,867,500	0	0	4,097,500	3,170,000
	Acres[2/]	18	55	1014	568	0	0	94	66
4	Tons	557,000	2,579,500	15,042,500	1,760,000	2,892,500	425,000	147,000	599,000
	Acres[2/]	13	43	342	48	70	6	5	16
5	Tons	445,000	0	1,980,000	0	1,000,000	0	0	1,062,500
	Acres[2/]	10	0	47	0	21	0	0	23

1/ Categories determined by LIS Land Use work group.
2/ Determined from Connecticut DOT maps using an average deposit depth for the subregion.
3/ Includes deposits on suburban medium and low density, urban low-suburban high density, and urban high density residential lands; commercial, utility, transportation, institutional, recreational, and water area lands. Also deposits on State forest lands, parks, and military reservations.
4/ Forest lands depicted on land use maps. State forests excluded.
5/ Light and heavy industrial.

APPENDIX G

DETAILED EVALUATION OF ALTERNATIVE MEASURES

Table G-1 is an evaluation matrix. The numerous criteria listed in the left column are a synthesis of guidance obtained from many sources. Most notable among these are:

- The Principles and Standards (PAS) of the U.S. Water Resources Council.
- Various guidelines for the preparation of environmental impact statements (EIS) required under the National Environmental Policy Act of 1969 (NEPA). The EIS requirements were also incorporated by the WRC in its formulation of the PAS.
- The Coastal Zone Management Act of 1972.
- The LIS Plan of Study.
- Guidance from the New England River Basins Commission.
- Concepts developed by study participants.

By far the most significant of these sources was the PAS. For example, the criteria used in the matrix have been grouped so as to correspond with the four "accounts" required by the PAS. The environmental criteria correspond to the environmental quality (EQ) account. The economic criteria correspond to two accounts --- national economic development (NED) and regional development (RD). The social criteria correspond to the account on social well-being.

Alternative measures. The six alternative measures heading each column in the evaluation matrix are those considered by the work group as being most likely to contribute to meeting the demand for construction mineral commodities. They have been described in section 7.4.

Entries in the matrix. Entries in the evaluation matrix reflect judgments as to the most likely, overall, long term, and widespread effects of implementing a specific alternative with respect to the listed criteria. The alternative --- do not meet needs --- has been included for evaluation in order to weigh all alternatives in proper perspective. Most entries in the matrix use one or more of the following symbols:

+	significantly beneficial
++	outstandingly beneficial
-	significantly adverse
=	severely adverse
0	not applicable, or benefits and adversities are generally minor.

TABLE G-1. - EVALUATION MATRIX

CRITERIA	ALTERNATIVES: SEQUENTIAL LAND USE	MINE THE SOUND	MANUFACTURE SAND FROM STONE	IMPORTS FROM OUTSIDE THE REGION	LOWER SPECIFICATIONS	DO NOT MEET NEEDS	FOOTNOTES
1. Environmental Criteria							
(A) Quality							
1. Air	0	0	0 and -	0 and +	0	=	1
2. Water	0 and -	-	0 and -	0 and +	0	=	2
3. Land	+ and -	+	+ and -	+	0	=	3
4. Natural beauty	0	0	0	+	0	0	4
(B) Ecological Systems							
1. Terrestrial							
a. Plants	0	0	0	0	0	0	5
b. Animals	0	0	0	0	0	0	6
2. Aquatic							
a. Plants	0	-	0	0	0	0	7
b. Animals							
(1) Anadromous	0	0	0	0	0	-	
(2) Resident	0	-	0	0	0	0	
(C) Scarce Resources							
1. Archeological-Historical	0	0	0	0	0	0	8
2. Biological	0	-	0	0	0	0	
3. Geological	0 and +	0	0 and +	0	0	0	9
(D) Irreversible Commitments	++	0	0	0	0	0	10
(E) Summary of Environmental Rating	Fair	Fair to Poor	Fair	Good	Fair	Poor	11
2. Economic Criteria							
(A) Benefits							
1. Annual Benefits	High	High	High	High	Low	Low	
2. External Benefits	High	High	High	High	Low	Low	
(B) Costs							
1. Present worth of costs	Medium	High	High	High	Low	High	
2. Annual costs	Medium	High	High	High	Low	High	
3. External costs	Medium	Medium	Medium	High	Low	High	
(C) B/C Ratio	High/Medium	High/High	High/High	High/High	Low/Low	Low/High	
(D) Other							
1. Jobs	0	0	0	0	0	Low	
2. Population	0	0	0	0	0	Low	
3. Economic base stability	Medium	Medium	Medium	Medium	0	Low	
4. Environmental desirability	Medium	Low	Medium	High	Medium	Low	
(E) Summary of economic rating	Good	Fair	Fair to Poor	Poor to Fair	Poor to Fair	Poor	
3. Social Criteria							
(A) Real Income Distribution							
1. Primary incidence of benefits	Public	Public	Public	Public	Public	None	12
2. Primary incidence of costs	Public	Public	Public	Public	Public	Public	
(B) Health, Safety	++	+	+	+	0	=	13
(C) Educational, Cultural, Recreational	++	+	+	+	0	=	
(D) Emergency Preparedness							
1. Structural	++	+	+	+	0	=	
2. Energy conservation	-	-	=	=	0	+	
(E) Ability to meet other needs							14
1. Land use	+	++	- and +	++	+	=	15
2. Water quality	+	+ and -	+	+	0	=	2
3. Water supply	+ and -	+	+	+	0	=	16
4. Shoreline appearance	0	-	0	-	0	0	17
5. Erosion and sedimentation	+ and -	=	+ and -	++	0	=	18
6. Flood damage reduction	++	+	+	+	0	=	19
7. Recreation	+	+	+	+	0	-	20
8. Fish & Wildlife	0	=	0	0	0	- and 0	21
9. Transportation	++	+	+	+	0	=	22
10. Minerals	++	+	+	+	0	=	
11. Power	++	+	+	+	0	=	23
(F) Legal-Judicial Involvement	+	+	+	0	0	0	24
(G) Institutional							
1. Agency primarily responsible	Local, State, & Fed.	State & Fed.	Local & State	State & Fed.	State & Fed.	Local & State	
2. Ease of administration	=	=	=	-	0	0	
3. Preferability of Federal action	0	A	0	A	A	0	25
(H) Political							
1. Ease of creating new institutions	-	-	-	N/A	N/A	N/A	
2. Ease of passing laws	=	=	=	N/A	N/A	N/A	
(I) Other							
1. Community continuity	++	++	++	++	0	=	
2. Environmental attractiveness	+	=	+	+	+	=	
3. Years to implement	1 - 5	10	10	N/A	N/A	N/A	
(J) Summary of Social Listing	Fair	Fair	Fair	Good	Fair	Poor	26

FOOTNOTES FOR THE EVALUATION MATRIX

1. Regional air quality would be adversely affected if needs for construction mineral commodities were not met. Aggregates are utilized in construction of flues, stacks, and chimneys required by industry and power plants to disperse gases. Dust from mining operations is presently controlled by water sprays and regional effects are minimal.

2. Regional water quality would be adversely affected if the needs for construction mineral commodities were not met. Septic tanks, regional sewage collection systems, and treatment and disposal facilities require aggregates in their construction. The water table can be protected during land mining operations. Long term effects of mining in the Sound, to water quality per se, are not likely to be as severe as in the short term.

3. To not meet the needs for construction mineral commodities would forego many structural improvements to the land. Land mining areas can be reclaimed after the interim use of mining. In many instances, land areas are improved after mining operations --- man-made lakes can be created.

4. Evaluation precludes the option to create beauty --- for instance, beaches, lakes, and recreation areas. With proper reclamation procedures, visual disruptions would be short term and local in nature.

5. To not meet the needs precludes the option to increase agricultural productivity by structural measures such as dams for water storage during droughts and irrigation distribution systems.

6. Evaluation does not include human resources.

7. Whether mining operations in the Sound would have long-term and widespread effects on aquatic plants and animals is not known. Future studies should determine the severity of effects.

8. Archeological-historical areas are site specific; with early recognition, all alternatives would consider the value of preserving sites.

9. Mine operations often expose outstanding geological evidence which contributes to Man's knowledge.

10. Preemption of mineral resources by urban or suburban sprawl is essentially an irreversible commitment. Sequential land use planning would limit mineral resource preemption.

11. Criteria have been rated Poor, Fair, Good, with respect to most likely, overall, long-term, and widespread effects of implementation.

12. Public means all consumers --- individual homeowners, industry, and government.

13. Any alternative by which needs are fulfilled or partially fulfilled, will be beneficial in terms of Health and Safety.

14. Entries reflect a judgment as to whether the net effects of an alternative program will compliment (+), highly compliment (++), conflict (-), or highly conflict (=) with other LIS planning reports.

15. To not meet the needs would preclude many structural uses of the land. Extraction of sand and gravel and stone from the land conflicts with other uses during the interim period of mining. Imports or mining the Sound would produce fewer land use conflicts.

16. To not meet the needs would prevent the increase of water supply through structural means --- dams. Mining sand and gravel from land could have negative aspects on water supply if the water table is not protected.

17. Imports would require an increase in barge facilities which could cause detrimental effects to shoreline appearance.

18. To not meet the needs would preclude solving erosion and sedimentation problems through structural measures. Mine operations on land cause erosion problems but erosion can be controlled through proper reclamation procedures. Dispersal of fines caused by mining operations in the Sound may be significantly adverse. Studies should be made to determine the magnitude of the effects.

19. Any alternative by which needs are fulfilled will be beneficial in reducing flood damage through structural means.

20. To not meet the needs would preclude structural measures in providing recreational facilities or the creation of beaches. Land can be reclaimed for recreational facilities after the interim use of mining.

21. To not meet the needs could affect the propagation of certain species which require structural measures --- fish ladders and hatcheries. Mining the Sound could highly conflict with certain species. Studies should be made to determine the magnitude of the effects.

22. Any alternative by which needs are satisfied would be beneficial in providing transportation facilities.

23. To not meet the needs would be significantly adverse in providing power plant facilities.

24. An "0" rating reflects the judgment that implementation of the program will require insignificant legal or judicial involvement. A "+" indicates severe legal or judicial involvement.

25. 0 = Federal action not needed.
A = Federal and State action needed.

26. Only sequential land use can fulfill all needs.

APPENDIX H

A MINING ACT OUTLINE

This model is excerpted from a paper presented by Professor W. E. Coates, School of Landscape Architecture, University of Guelph, Guelph, Ontario, at Sixth Forum on Geology of Industrial Minerals, held in Ann Arbor, Michigan, in April 1970. It is presented here only to illustrate the items that might be considered in land use legislation.

Coates, W.E. Surface Mining Rehabilitation In Ontario -- Legislation and Implementation. Proc. Sixth Forum on Geology of Industrial Minerals, Ann Arbor, Mich., April 2-3, 1970, ed. by W. A. Kneller. State of Michigan, Dept. of Natural Resources, Geol. Survey Div., Miscellany 1, pp. 5-14.

General Provisions

1. Definition of terms and exemptions
2. Requirements for approval, by the Chief Engineer of Mines, of a site plan for each existing operation as well as new operations
3. Site plan requirements
4. Public notice of filing of site plan
5. Sixty day review period for government departments and public prior to approval of the site plan
6. Right of appeal of aggrieved parties
7. Periodic revision or updating of site plan
8. Performance deposits
9. Rehabilitation procedures
10. Conservation of topsoil and overburden
11. Perimeter screening
12. Setbacks from property lines
13. Buildings and site maintenance
14. Times of operation
15. Dust control
16. Drainage of hazardous water accumulations
17. Fencing of site and access control
18. Truck entrances and traffic safety
19. Noise control
20. Blasting -- limits of energy release
21. Roadside borrow pits
    a. Exempt from regular site plan requirements
    b. Temporary use only -- 12 months maximum
    c. Rehabilitation required by operator
    d. Special administration and inspection procedure

Three of these general provisions, site plan requirements, performance deposits, and rehabilitation procedures are of outstanding significance and should be examined in detail to understand the scope and methods of enforcement of the proposed legislation.

Site Plan Requirements

Detailed site plan requirements include the following information:

1. Site location, size, dimensions and true shape
2. Description of adjoining land use as well as location and use of all structures within 500 feet of mining property site boundaries
3. Description and location of all existing and proposed structures on the site
4. Complete topographic description of existing and proposed conditions
5. Drainage provisions and process water features
6. All roads and connections to public roads
7. Location of stockpiles of product, overburden and topsoil
8. Progressive and ultimate rehabilitation program
9. Proposed after-use of land upon completion of rehabilitation

Rehabilitation Requirements

Rehabilitation requirements include the following:

1. Final topography to be in accordance with the approved plan
2. Adequate amounts of topsoil and overburden be retained on the site, in erosion-free stock piles, to provide for rehabilitation earthwork
3. Transition slopes be established on all perimeter working faces at the perimeter of the site
4. Excavated areas be covered with topsoil and adequate vegetation cover be established to prevent surface erosion
5. Surfaces intersecting water be at a maximum slope of 1-1/2:1
6. Sanitary landfill operations meet the requirements of various public health and water agencies, with respect to maintenance of ground water quality
7. Tree screening be established to a minimum height and at a minimum density on all portions of the site within 50 feet of public road rights-of-way and within 300 feet of abutting residential property

Performance Deposits

Performance deposits would be required from each operator on a yearly basis, at a fixed rate per ton, of material shipped during the previous year. Upon completion of rehabilitation and abandonment of the mining site, the accumulated deposit and interest would be refunded to the operator with provision for proportional, partial, repayment during progressive rehabilitation. In a case of non-rehabilitation the operator would forfeit the amount in his deposit account and the appropriate government agency would have the necessary rehabilitation carried out and paid for from the forfeited deposit.

COORDINATING GROUP
LONG ISLAND SOUND REGIONAL STUDY
As of the date of this report

New England River Basins Commission	*R. Frank Gregg
State of Connecticut	Richard Dowd
Connecticut Coastal Zone Management Committee	Senator George L. Gunther
Connecticut Office of State Planning	Horace Brown
State of New York	John A. Finck
Interstate Sanitation Commission	Thomas R. Glenn
Tri-State Regional Planning Commission	Richard DeTurk
Atomic Energy Commission	Walter Belter
Department of Agriculture	Robert G. Halstead
Department of the Army, Corps of Engineers	Lawrence J. Bergen
Department of Commerce	Russell T. Norris
Department of Housing and Urban Development	Sheldon Gilbert
Department of the Interior	William Patterson
Department of Transportation	Royal E. Grover, Jr.
Environmental Protection Agency	Walter M. Newman
Federal Power Commission	Martin Inwald
Nassau-Suffolk Regional Planning Board	Lee E. Koppelman
Citizen Advisory Committee	Roger Shope
Research/Planning Advisory Committee	Lawrence E. Hinkle, Jr. M.D.
Study Manager	**David A. Burack

* Chairman ** Executive Secretary

WORK GROUP ON MINERAL RESOURCES AND MINING

Department of the Interior, Bureau of Mines	*C. Gordon Leaf
Department of the Interior, Bureau of Mines	James J. Hill
Department of the Interior, U.S. Fish and Wildlife Service	Ronald Sake
State of Connecticut	Sidney Quarrier
State of Connecticut	Harry L. Siebert
State of New York	John J. Dragonetti
State of New York	Robert H. Fakundiny
State of New York	George Toung
Department of the Army, Corps of Engineers	Arthur F. Doyle
Department of the Army, Corps of Engineers	Carl Hard
Nassau-Suffolk Regional Planning Board	Dr. Edith G. Tanenbaum
Citizen Advisory Committee	James Corrigan, Jr.
Citizen Advisory Committee	Claire Stern
Research/Planning Advisory Committee	Dr. Theodore Combs
Research/Planning Advisory Committee	William Lund

* Chairman

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